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PROGRESS THROUGH RESEARCH

Survey of Agricultural Research in Maryland

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EIGHTY-FIRST ANNUAL REPORT

BULLETIN A-164 APRIL 1970

PROGRESS THROUGH RESEARCH

Survey of Agricultural Research in Maryland

EIGHTY-FIRST ANNUAL REPORT

1967–1968

VERSITY OF MARYLAND
ULTURAL EXPERIMENT STATION

BULLETIN A-164
COLLEGE PARK
MARYLAND
APRIL 1970

BOARD OF REGENTS OF THE UNIVERSITY OF MARYLAND

AND

THE MARYLAND STATE BOARD OF AGRICULTURE

1967-1968

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AGRICULTURAL EXPERIMENT STATION
COLLEGE PARK, MD.

To The Governor of Maryland
the Board of Regents,
and the President of the University of Maryland:

I transmit herewith the Eighty-first Annual Report of the University of Maryland Agricultural Experiment Station, as established by Act of Congress, March 2, 1887, containing an account of research and experiments, conducted during the fiscal year ending June 30, 1968, and a statement of the receipts and disbursements for the same period.

I. C. Haut
Director

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Contribution No. 4236 of the Maryland Agricultural Experiment Station, Administration.

Ms. rec'd. 7-24-69

AGRICULTURAL ECONOMICS

Dairy Adjustment and Supply Response in Maryland and the Northeast

This study is concerned with the future economic position of Maryland dairymen in relation to dairymen in other Northeast states; and of the Northeast to other regions of the country. The market for milk produced by dairymen in Maryland is influenced by national demand as well as demand within the Northeast region. Adjustments made by producers both in Maryland and other states to improve efficiency and increase supplies will materially affect the portion of total volume of milk that producers in Maryland can economically provide. Technological developments that result in a change in form of milk consumed may cause shifts in producing areas.

Dairying is a major farm enterprise in Maryland. Proximity to major urban areas has provided farmers with a market for large quantities of milk products. Institutional restrictions, transportation costs, and shipping difficulties have tended to reserve these markets for nearby producers. However, changes are taking place which may reduce this advantage for nearby producers. The advantage of nearness to market may be lost in part due to improved transportation facilities, technological improvements in processing, and changes in consumer habits.

Substantial data were collected, summarized and analyzed relative to dairy products processing, distribution and consumption. Briefly, the total number of dairy processing plants declined from 87 to 42 between 1954 and 1967. During the same period, total milk processed in plants increased from 1.3 to 1.5 billion pounds per year. Average production of milk has doubled, and ice cream production has tripled on a per plant basis during the past decade and a half. Most of the declines in numbers of dairy processing plants have occurred in plants with fewer than 20 employees. Production per man year employed has increased in both milk plants and ice cream plants. However, production per production employee rose faster than production computed on the basis of all employees of the firm.

There were approximately 3,600 herds in Maryland from which milk and cream were sold in 1967-1968. Tentative projections indicate 2,300 herds in 1976 and 1,600 herds in 1986. Average herd size is expected to increase from nearly 50 cows per farm in 1968 to 63-67 cows in 1976 and 72-84 cows by 1986.

Milk cow numbers should continue to decrease as milk production per cow increases faster than total milk market requirements. Milk cows may decline to 145,000-155-000 by 1976 and 115,000-135,000 by 1986. The ratio of Maryland cow numbers to United States and Northeast cow numbers has steadily increased since 1940.

The micro level of dairy adjustment analysis made substantial progress in 1968-69. An analysis of individual dairy farm firm adjustments in Maryland's Area 19 was completed. The focus of this analysis has been the determination of absolute and relative adjustments on surviving dairy farm firms over the 1956-66 period. Earlier reports and analyses focused on total sample adjustments in firm size, firm growth and firm resource productivity.

Gross value of milk sales increased sharply over the 1956-66 decade—from $13,089 to $28,420 per farm. The largest per farm increases occurred on the farms with the largest herds. These farms with 60 or more cows increased in numbers from 14 to 34 and gross sales of milk increased from $30,370 to $50,342 during the 1956-66 period. Substantial increases have occurred since then because of the continued rise in milk prices and average levels of milk sold per cow.

Factors underlying the increase in average sales of milk per farm and their proportional contribution were: 1) number of milk cows per farm (44 percent); 2) average pounds of milk sold per cow (40 percent); 3) increase in average price level of wholesale raw fluid milk (13 percent); and increase in butter fat content of milk sold (3 percent). Since 1966, the relative importance of higher milk prices has increased and the other three factors have decreased in relative importance in explaining the continued shift toward increased milk sales per dairy farm.

The most significant changes in productive resource use on these dairy farms have occurred with respect to efficiency and productivity of human resource use. Dairy farmers now handle more milk cows and more crop and pasture acres as well as obtaining more milk per cow and feed nutrients per crop acre. Dairymen have made major shifts toward feeding more silage and concentrates per cow as a means of increasing production per cow and reducing farm labor requirements per cow for both crop and dairy chore activities.

Project A-18-au

Organization of the World's Agricultural Resources

Institutions affecting agricultural productivity vary widely throughout the world. Field patterns are an illustration. Fields tend to be large and rectangular in family commercial farming, small and circular in parts of tribal Africa shifting hoe cultivation, rectangular and greatly fragmented in the north-Indian Hindu village, and small and irregular in the Japanese village.

Management institutions show a similar variety. On the plantation the choice criteria used in decision-making may be chiefly profit maximization. On the socialized farm in Algeria, conformance to socialist doctrine becomes of primary importance. In the north-Indian Hindu village, tradition dictates most of the choices. In some tribes which practice shifting hoe cultivation in Africa, the

Dr. Phillips Foster, center, and his field assistant, right, show an Indian villager how they are mapping his village. Dr. Foster spent his sabbatic leave in India on a Fulbright senior research grant. While there, he continued his work on the organization of the world's agricultural resources by restudying a village which 12 years previously was the subject of his Master's thesis.

decision to move to an entirely new region may be occasioned simply by the death of a wife.

The objective of this project is to build up institutional profiles in agriculture for several strategically located systems of agricultural resource organization. An institutional profile is defined as the set of institutions used by and affecting the existing or potential productivity of a group of people who gain their principal livelihood through agriculture. Such institutions not only center around the resources used in agricultural production — land, labor, capital, and management — but also include the institutions involved in marketing.

Institutional profiles built up by using the methodology of this project have been published as experiment station miscellaneous publications with the following titles: *The Structure of Algerian Socialized Agriculture,* MP 527; *The Structure of Buganda Rudimentary, Sedentary Agriculture,* MP 590; *The Structure of Plantation Agriculture in Jamaica,* MP 623; and *The Structure of Shifting Agriculture in Two Chewa Villages,* MP 629. In unpublished thesis form, institutional profiles for agricultural resource organization have been completed for the collective farm in the Soviet Union and feudal village irrigated agriculture in Iran.

The project leader was on sabbatic leave during the project year covered by this report and continued work on the project by doing field work in India under sponsorship of a Fulbright senior research grant. He restudied a village which he had studied 12 years earlier for his Master's thesis.

Project A-18-ax

Optimizing Returns to Resources on the Eastern Shore of Maryland

Increased commercialization and market-oriented production planning on farms on the Eastern Shore of Maryland as well as in other parts of the nation increases the dependency of farm resource earnings on non-farm activities. One phase of this project was concerned with measurement of the interdependency of farm resource earnings of the Eastern Shore with other sectors of the national and state economies.

Studies of the interindustry relationships between the farm sectors and other sectors usually begin with the construction of an input-output or from-to table. In constructing the table, the total economy is divided into industries or sectors. A production period is then defined, usually one calendar year, and data are collected concerning the transfers or purchases of goods from each sector. Outputs of goods and services of some firms become inputs within the same firms or other firms within the same industry or in other industries or final consumption.

Data were compiled for construction of an input-output table with emphasis on Maryland agriculture for the calendar year 1963. The data in the accompanying table were computed from a simplified 8-sector input-output table of the total economy. In this table, Maryland farms were viewed as an industry.

These estimates indicated that of each $100 worth of goods and services flowing from Maryland farms in 1963, about $13 represented farm outputs, $18 was derived from manufacturing sectors, $16 was derived from the services sector, $30 was derived from interstate imports, $18 was derived from households and the remainder was derived from construction, inventories and foreign imports. One reason interstate imports appear so large (in addition to the fact that feeder cattle and other items are imported and used as inputs on Maryland farms) is the fact that some items are transported through Maryland for foreign export. Once these items were brought into the state, they were combined with Maryland production and could not be identified.

For each $100 worth of output from Maryland farms, $13 returned to farm inputs, $44 to the manufacturing sector, about $12 each to interstate and foreign exports, $14 to households, and the remainder to construction, services and inventories.

Almost half of the farm output went to the manufacturing sector for processing. This includes most of the products such as meat, dairy products, and vegetables which are processed in non-farm firms before final human consumption. In addition, much of the feed grain is processed and combined with other feeds in the manufacturing sector before resale to farms as feed inputs. An example of this is illustrated in the accompanying photograph in which an Eastern Shore corn grower is delivering corn from the field to the local grain elevator.

Origins and Destinations of Total Value of Farm Output by Economic Sectors, Maryland, 1963.

Origin of Value *Sector*	*Percent*	*Destination of Value* *Sector*	*Percent*
Farms	13.4	Farms	13.4
Construction	1.6	Construction	.9
Manufacturing	18.4	Manufacturing	44.4
Services	15.6	Services	1.2
Interstate imports	30.3	Interstate exports	12.6
Foreign imports	1.2	Foreign exports	12.4
Inventories	1.4	Inventories	.9
Households	18.1	Households	14.2
Total	100.0	Total	100.0

Project A-18-ba

An Economic Study of Agricultural Labor in the Northeastern States

A review and summarization of farm survey records taken in Maryland during the past decade is still in process. The purpose of this review is to establish farm labor force characteristics and relationships at various times for selected types and sizes of Maryland farms to determine past trends and levels.

A farm labor survey questionnaire was developed and pretested in 1967 and distributed to other farm labor research workers in the Northeast. The farm survey work for the Western Maryland area was completed between August 1967 and December 1967. A purposive field survey design was used to obtain the full range of available labor resource experience on Western Maryland farms.

A total of 223 usable farm records were obtained. Specialized dairy farms predominated in the area. The numbers and types of records were: 124 dairy farms, 36 beef farms, 11 general farms, 38 fruit farms, and 14 poultry farms. This survey work phase of the project was supported in part by funds from a special research grant from the U. S. Department of Labor.

Principal Accomplishments. Commercial farms vary widely in size and composition of labor force within and among types of farms. There is a wide distribution of levels of technical labor productivity within and among different farm size classifications. The rising levels of on-farm wage rates per unit of time during the past decade have increased the importance of wage rate structural changes within and among firms. The expected future rise in farm wage rates must be offset by increased technical labor productivity if labor costs per unit of farm output are to be kept at reasonable levels within farm firms.

There appear to be substantial gains in labor productivity per worker on individual farms as the volume of output per farm increases up to the point at which the managers can fully utilize their available farm labor force. The degree of mechanization of farm operations affects the potential size of business as well as the potential productivity of farm labor. Of course, the basic inherent qualities of the human resources on farms will affect the productivity levels actually achieved. The motivations, attitudes and efforts devoted toward productive work will also influence the performance levels attained irrespective of the types of capital and land resources associated with the farm labor force.

The average labor productivity per worker tended to be higher on the farms with larger acreages and larger numbers of animal units of livestock. Therefore, it was probably higher than the existing levels of labor productivity on all farms of similar types in Maryland and the Northeast. The labor productivity data are expected to be representative of average and maximum labor productivity obtained on the more efficient commercial farms in Western Maryland and throughout the Northeast region.

The *1967 cross-sectional* data within the dairy type of farm classification indicated that size of business in terms of milk cows per farm and crop acreage per farm had a significant effect on the level of technical labor productivity attained on individual farms. This general theoretical and empirical relationship has been demonstrated in many farm management and production economics empirical research studies conducted at the Maryland Agricultural Experiment Station and other stations throughout the Northeast and the nation.

The significance of these new data relates to the changes in both *the shape* and *the level* of the size of business-labor productivity relationships. Average labor productivity is now higher at each size of dairy herd level than in the past. *Average labor productivity per worker now continues to rise over a larger range of cow herd size as size of herd per farm increases than in the past.*

The average number of man-equivalent in the farm labor force for a given size of herd has tended to decline over time as mechanical processes have been substituted for hand processes in the on-farm milk production process. However, this *time-series* type of farm business adjustment which permits the elimination of one or more full-time or part-time workers is restricted to the farm firms with the larger sizes of labor force studied during the earlier periods. The farms with relatively small sizes of milk cow herds and a minimum size of farm labor force for effective operation must expand the size of herd or milk production per cow at a faster than normal rate in order to retain their competitive position in the race toward higher on-farm labor productivity in the production of milk for commercial wholesale milk markets in the Northeast.

The cross-section technical labor productivity data on fruit farms indicate that there is little tendency for labor productivity to increase in terms of fruit acres handled per man-equivalent as size of labor force increased. However, acreage of fruit per man did tend to increase as acreage of fruit per farm increased up to approximately 200 acres. The eight largest fruit farms in terms of both full-time and seasonal workers combined appeared to be somewhat less efficient in the use of on-farm labor. However, they had other advantages in packing, processing, storing and marketing their fruit output and fuller use of labor throughout the year.

The labor productivity per worker on the beef, poultry and general farms also tended to increase as acreage and number of animal units per farm increased. These productivity data will be reported in more detail in separate type of farming publications.

Usefulness of Findings. The results of this study of farm labor productivity and labor use alternatives on Maryland and Northeast farms will provide data to assist farm businessmen in evaluating the economic and managerial impact of changes and adjustments in their technical production methods and facilities. Many farmers must make decisions with respect to adding more capital inputs and making labor adjustments as they expand the sizes of their operations to improve their physical labor productivity and economic returns to on-farm labor. Other farm managers and farm workers must decide: 1) when and to what extent to withdraw human and non-human resources from the farm production process; and 2) what types of adjustments in human skill levels and capital inputs will be needed for effective off-farm resource employment.

Project A-18-bc

Maryland Farm and Open Country Real Estate Transfers

This project deals with Maryland farm and open country real estate transfers. The specific objectives of this study are: (1) to discover the number of farm and open country real estate transfers in Maryland by county and election district; (2) to obtain information regarding the price of this land; (3) to discover the size of the tracts being transferred; (4) to obtain information on the types of transfer; and (5) to obtain information on the use of credit, type of lender and other pertinent information shown on the Property Transfer Record.

Since land is agriculture's primary resource, and because it has been increasing in price very rapidly during recent years, it is desirable that we know more about the market for Maryland farms and open country real estate.

Three computer programs have been developed to process and analyze the data with respect to (1) consideration, (2) financing, and (3) assessment.

The consideration program examines — for each county and election district — the transfer for which there was a consideration. This program sorts the land transfers into 10 size categories and shows the number of transfers, total acres transferred, average size of transfer, total consideration and average price per transfer and per acre for each of the 10 size categories. This program then summarizes the previously mentioned information without regard to size categories.

The credit program examines, for each county and election district, transfers involving the use of credit. The program shows, with respect to eleven categories of lenders, the number of transfers, total acres transferred, total consideration, total amount of credit used and the credit as a percent of the total consideration. It also shows the percent of transfers, acres, consideration and credit furnished by each of the eleven categories of lenders. This program then summarizes the previously mentioned information without regard to type of lender.

The assessment program examines, for each county and election district, all the transfers for which there was a recorded assessment. One part of the program shows, for five land use categories, the number of transfers, total acres transferred, total assessment, and assessment per acre with percentage of transfers, acres and assessment for each of the five categories. This program further shows, with respect to transfers with or without buildings and for all transfers, the total acres transferred, total assessment and assessment per acre.

This computer program also makes an assessment and consideration analysis for improved land, unimproved land and for all transfers. It shows the number of transfers, total acres transferred, total assessment, total consideration, average assessment per acre, average price per acre and assessment as a percent of consideration.

Fourteen county reports were published from this project during the fiscal year 1967-68. These county reports were published with a standard title, "The Transfer of Farm and Open Country Real Estate in ——— County, Maryland, 1964." Reports were published for the following Maryland counties: Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Washington, Wicomico and Worcester.

These county reports were distributed to farmers, assessors, credit agencies, county planning groups, agri-business personnel, Extension agents, vocational agriculture teachers, administrators and other individuals with an interest in the land market.

The collection and processing of Property Transfer Records for 1965 was continued.

Project A-18-bb

Comparative Impact of Current and Alternative Systems of Taxation in Maryland on Farmers and Other Economic Groups and Among Counties

Property values and personal incomes are the two criteria used as a basis for relative ability and tax effort among counties in Maryland in connection with state aid for county functions. Several different interpretations of property values, and different combinations of property classes, are used in the seven county programs in which the state gives financial aid. One property value concept could serve as a basis for all programs.

Personal income has recently been added to the measure of county tax capacity, and applies to two important functions—public education and police protection. However, it has much less weight in the relatively low income counties. Therefore, the burden of local upport still falls largely on real estate. The gradual exemption of personal property from county taxation will inensify the real estate tax burden. This burden falls especially heavy upon farm owners since real estate is the major inestment of farmers and income from arm operation is relatively low in relaion to property tax liability.

Major tax sources, for both state and ounty purposes, have not, in recent years, increased as rapidly on the average as have budget requests or needs. This gap, in the case of the state, has been met by a combination of two major fiscal procedures: (1) utilizing various non-recurring revenue measures; and (2) increasing the tax rates or productivity of certain tax sources.

In counties, however, property taxes are the major source of local revenue, despite recent legislation giving counties the power to levy up to one-half the amount of the personal income tax for state purposes. For most counties such local income taxes will not afford much property tax relief. Meanwhile, counties have also been granted the optional power to exempt tangible personal property from county taxation. Moreover, most of the counties have, by necessity of population growth or obsolete or inadequate public facilities, resorted to additional bonded indebtedness which, under rising interest cost, adds to property tax levy requirements. The state property tax rates will also most likely continue their upward trend unless some other provisions are made to meet state bond annuity requirements.

Project 19-ac

Demand for and Availability of Water Oriented Recreation Facilities in Maryland: An Economic Analysis

Campground Study — Twenty thousand copies of Leaflet No. 55, "A Guide to Private Campgrounds in Maryland," May, 1967, were distributed during the summer of 1967 from county Extension offices and tourist information booths throughout the state. This leaflet listed the location, size, and facilities of privately owned commercial campgrounds throughout Maryland. These campgrounds had provided information and given permission for such a listing.

In spring 1968, a questionnaire was sent to each county planning and zoning commission in Maryland asking for new campgrounds opened since the 1967 listing and for information on zoning regulations applied to campgrounds. Most replies were received and will be tabulated and analyzed.

Marina Study — A PhD dissertation, "An Economic Analysis of Marinas in Maryland" was completed; and arrangements were made to have this issued as a miscellaneous publication of the Maryland Agricultural Experiment Station in cooperation with the state's Department of Chesapeake Bay Affairs. The major author rewrote the dissertation for publication, incorporated organizational and editing changes suggested by the other authors (Dean F. Tuthill, Department of Agricultural Economics and William B. Matthews, Jr., Department of Chesapeake Bay Affairs) and the completed manuscript was submitted for publication.

Project A-19-ad

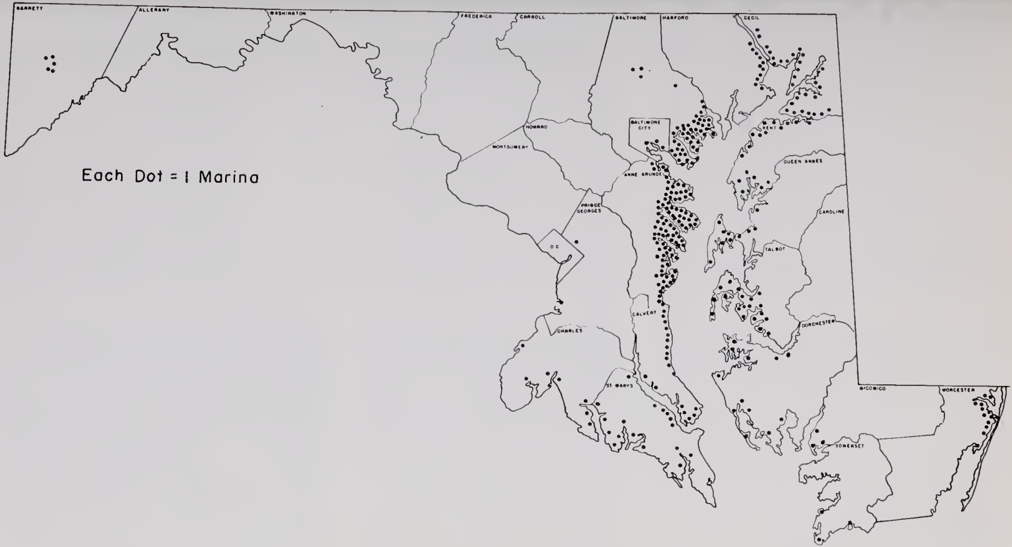
An Analysis of the Effects of U.S. Farm Policies on Maryland Agriculture

The table below shows that the yield distribution of farms producing Type 32 tobacco differs materially from the flue-cured yield distribution. Approximately 80 percent of the producers of flue-cured tobacco were within the 80 percent and 120 percent yield limits provided in the acreage-poundage program, 85 percent of the acreage allotments and 85 percent of the flue-cured quota are produced on farms whose yields were within the 80 to 120 percent limits.

On the other hand, Type 32 growers show a much wider yield variation. Only 56 percent of the farms are within the 80 to 120 percent yield limits provided in the acreage-poundage program,

Acerage-Poundage, Maryland Compared to Flue-Cured Tobacco

	Maryland				Flue-Cured[a]			
		Percentage of				Percentage of		
Yield Groups	Farms	Allotment	Quota	Yield Adj.	Farms	Allotment	Quota	Yield Adj
under 80	26	15	12	+19.4	10	6	4	+11.5
80 to 120	56	63	62	− 0.4	80	85	85	b
over 120	18	22	26	− 9.7	10	9	11	− 5.8



Marinas in Maryland (1965) as located for study and economic analysis.

while 63 percent of the allotment and 62 percent of the quota is produced on farms whose yields were within this range. This wide difference means that no yield adjustments were required under the acreage-poundage program on more than four-fifths of the flue-cured farms, while more than a third of the Maryland farms would be subject to substantial adjustments. Even more important is the fact that the low yielding Maryland tobacco farms would have received an upward adjustment of almost 20 percent on the average, while the high yielding (normally high quality) Maryland farms would have experienced an almost 10 percent reduction under an acreage-poundage program. These factors plus the unusually significant impact of weather conditions on the quality of the Type 32 tobacco crop resulted in the conclusion, from this study, that an acreage-poundage program should not be applied to Type 32 tobacco without major modifications and even then it probably would not result in improving quality and making a better adjustment of supply to demand.

Project A-19-ae

The Export Market for Maryland Agricultural Products

A research team is concentrating on an analysis of Spain in order to develop its estimated long-run potential as an importer of Maryland agricultural products. Spanish consumption, price, population, and income data were assembled. A preliminary report of the 1975 consumption of agricultural products in Spain was developed, based on estimated income elasticities. Past changes in Spain's agricultural production were documented, and projections to 1975 established. A beginning was made on the analysis of Spain's past and current development and trade policies, and their possible impact on future demand and trade.

Project A-26-bm

The Delmarva Poultry Industry in Interregional Competition

It was necessary to restructure this project to reflect more recent needs of the poultry industry and to indicate the overall relative efficiency of the Delmarva Poultry Industry as compared to other areas with which it competes.

To give the study greater depth, new economic factors have been introduced and Mr. John L. Crothers has collaborated in the competitive aspects of grain and transportation areas.

The project is expected to be completed by July 1969 under the released title of "The Delmarva Poultry Industry in Interregional Competition."

The Delmarva broiler industry has long been a leader in the production and marketing of broilers in the eastern part of the nation. The Delmarva area produced more broilers than any other state until 1954 when Georgia took the lead in production. Since that time, other states in the East have also made rapid growth in broiler production.

By 1955 the major broiler areas were Delmarva, Alabama, Arkansas, Georgia, Maine, Mississippi, North Carolina, Virginia and Texas. These nine areas produced almost 66 percent of total U.S. broilers in 1955. Delmarva's share of the total production was about 18 percent in the nine major areas and about 12 percent of the nation's production. However, since 1955, other areas have grown in broiler production more rapidly than Delmarva. While the nine major areas produced over 83 percent of the nation's broilers in 1968, Delmarva's share of the production had dropped to less than 13 percent of the nine area total and about 10 percent of national production. Delmarva's rank among the major broiler areas had dropped to 4th place in 1968.

United States production of broilers increased at an average annual rate of 7.4 percent from 1959 to 1968. Delmarva's average production increase per year in the same period was only 5.5 percent while four major areas (Arkansa, Alabama, North Carolina and Mississippi) expanded production at an average annual rate ranging from 10 to 14 percent.

The problems investigated in this study are: (1) the reason for the decline n the Delmarva broiler industry relaive to the other major producing areas; and (2) whether markets exist in which Delmarva broilers have a competitive advantage over broilers from present major surplus producing areas.

The specific objectives of this study re:

1) To compare major production and marketing cost factors on Delmarva to other major broiler producing areas.

(2) To determine the absolute value of selected economic factors contributing to Delmarva's comparative advantage or disadvantage in broiler production and marketing relative to other major broiler areas.

(3) To indicate the major markets in which Delmarva has a comparative advantage or disadvantage relative to other areas when the aggregate effect of selected economic factors is evaluated.

The concept of comparative advantage is an economic concept widely used in evaluating international trade between nations. However, the principles underlying the concept can also be applied to areas or regions within a nation. When an area has a comparative advantage in production and marketing of a commodity, economic factors are favorable to an expansion, or at least a continuation of production. Conversely, a comparative disadvantage should be a warning of production shifts to other areas, with a subsequent loss of market outlets and a decline in the importance of the commodity relative to other areas.

Several techniques provide some indication of the comparative advantage of one area over another. An analysis of historical patterns in production, market share, and rate of change of these two things are such indicators. Although change itself does not necessarily reflect comparative advantage, it may be assumed that in the long run the changes tend to reflect economic forces within and relative to other areas.

If demand factors for a product are such that rapid production increases are needed, many areas find production of that commodity more profitable than

Relative market share of broilers produced by individual areas within the nine major production areas and aggregate relationship of these areas to total national production for selected years.

Area	1959	1961	1963	1965	1967	1968	Change in Share 1959 to 1968
	Relative Market Share (percent)						
Delmarva	13.98	12.86	13.85	13.21	12.87	12.60	−1.38
Alabama	12.40	12.96	13.46	14.83	15.01	15.18	+2.78
Arkansas	12.85	15.00	15.34	16.65	16.90	17.05	+4.20
Georgia	23.75	22.79	21.24	20.95	20.63	20.18	−3.57
Maine	4.56	3.83	3.77	3.56	3.42	3.25	−1.21
Mississippi	8.43	8.89	9.24	8.73	9.11	9.40	+0.97
North Carolina	10.77	12.20	12.71	12.19	12.16	12.14	+1.37
Texas	9.03	8.06	7.76	7.40	7.47	7.48	−1.55
Virginia	4.23	3.43	2.62	2.49	2.39	2.63	−1.60
Total Share of United States	73.46	76.69	80.62	82.48	83.43	83.31	+9.85

other alternatives for a period of time. When demand factors no longer call for such expansion and a temporary equilibrium between supply and demand is reached, those areas having the greatest comparative advantage continue to be major producers while those in a less advantageous position are forced to reduce production relative to the other areas.

Data on the comparative advantage between areas can be analyzed with applicable production and marketing coefficients to determine absolute advantage. Absolute advantage is simply the smaller cost, or greater return, or both, of producing in one geographical area relative to another. This can be stated in terms of an absolute value, *e.g.*, cents per pound of weight for broilers.

While the principles of comparative and absolute advantage are difficult to apply directly in an analysis of a commodity and area, the data generated is very useful in understanding the causes of, and relationships involved in area specialization, and the relative changes that occur between areas as a result of such specialization.

This study is divided into three sections. The first section compares by areas the historical trends in production, change in market shares, and other relevant economic factors affecting the broiler industry in the major production areas. In the second section, a critical analysis is made to determine the absolute value of selected economic factors affecting the comparative and absolute advantage and/or disadvantage of the Delmarva area relative to other areas. The final section of the study aggregates the effect of all selected economic factors to show the comparative and absolute advantage or disadvantage of Delmarva in relation to other areas in competition for markets in 11 major cities of the nation.

Some data in this study were obtained from secondary sources, including statistical publications of the United States Department of Agriculture, and various Experiment Station publications from areas considered in the study. Other data were obtained by letters and personal contacts with broiler industry leaders in the areas concerned.

Specific assumptions were made where appropriate and are so noted in the study. However, the following general assumptions were made in the study:

(1) The level of technological resources at both the production and marketing level for broilers were assumed to be equal in all areas from a physical standpoint but not management of these resources.

(2) Broilers of a given size and quality were considered perfect substitutes regardless of the area in which they were produced and marketed.

Project A-26-bo

An Optimum Location Of Livestock and Meat Marketing Facilities in the South

A PhD thesis was completed covering the livestock marketing simulation model as developed for the state. The monthly cost of transporting market livestock from supply points (farms) through existing markets to regional demand areas plus market charges amounted close to $31,000 in the six normative models developed. As expected, the livestock marketings deviated from what actually occurs as reported by the various markets involved. This indicates that probably such non-quantifiable factors as tradition, convenience, friendly treatment at the chosen market, etc., influence the choice of market by producers. Conversely however, no significant differences were found when the various services offered by the 14 markets included in the study were tested statistically.

Preplanned shocks to the normative model were administered which showed how the various markets withstood changes in: (1) volume of livestock handled and (2) marketing charge changes of competitors.

Project A-26-bp

Milk Assembly, Processing and Distribution Systems and Practices

Public interest in, and control over, the production, processing and distribution of milk for fluid use is probably greater than for any other agricultural commodity. The bulk and susceptibility of this product to bacterial contamination have contributed much to the development of an institutional environment which contributes materially to the direction and/or control of marketing systems and practices in the milk industry.

This study identified the major institutional arrangements existing in the Washington, D. C. metropolitan milk market at the end of World War II and traced the basic changes in these institutional factors during the subsequent twenty year period. It then determined the impact of these changes upon the evolution of marketing systems and practices in the area. These institutions were the agricultural cooperatives, the Washington, D.C. health regulations, the federal anti-trust statutes, and the federal minimum price order.

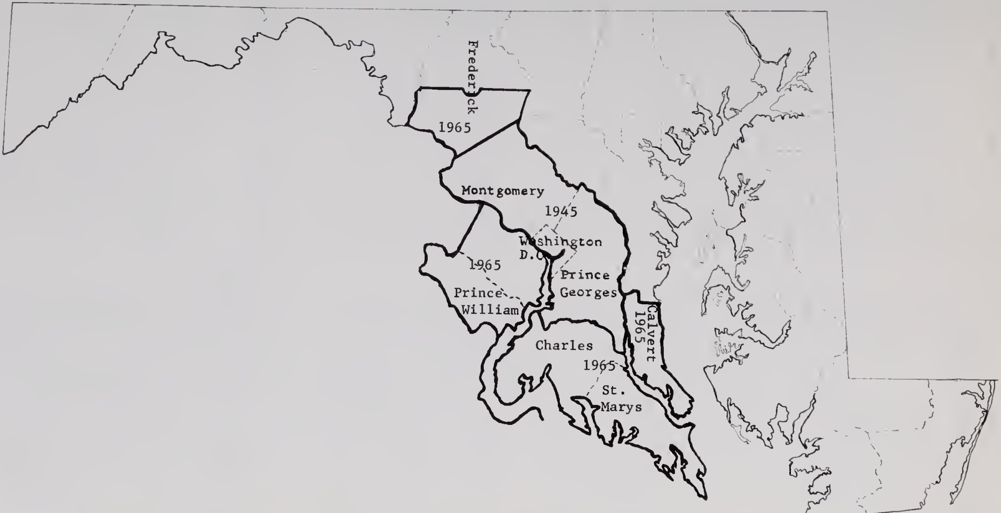
The cooperatives, through which group control is exercised over the business activities and the decisions of the member, initiated and modified farm handling and producer-pricing systems and practices within the framework of the other institutional factors tending to limit the activities of the cooperatives. If the institutional environment severely restricted the desired activities of the cooperatives and or other milk trade organizations in the market, these organizations initiated action and directed programs designed to change the institutional arrangement which prevented their desired modification of a marketing system or practice.

Prior to 1959 the anti-trust statutes, the Washington, D.C. health regulations, and the cooperatives themeslves were almost the exclusive factors in the institutional environment of the Washington, D. C. milkshed. These factors established the pattern of marketing systems and practices and directed the modifications which were made in these systems and practices after World War II.

In 1959, after extensive hearings, and after more than ten years of price bargaining between the cooperatives and the individual handlers in the market, the existing federal minimum price order was established. This order required that all handlers delivering milk on retail and wholesale routes in the defined marketing area pay the same minimum Class I and Class II prices to their producers for milk delivered to the handlers plant. This institutional arrangement was specifically free from anti-trust concern, and materially altered the entire system of producer pricing for the market. Under the order, producer price bargaining took place between organized producer groups and the Secretary of Agriculture at public hearings, according to standards set forth in the Agricultural Marketing Agreements Act. Handlers could appear at the public hearing, but were legally required to pay the minimum prices established by the Secretary.

Modifications in the District of Columbia health regulations also affected milk marketing systems in several major respects. (1) Termination of the war emergency provisions in 1950 ended the importation of milk from farmers not holding D.C. Health Department permits, and the local health regulations again protected the market for local producers. (2) A rapid shift from the use of cans for farm handling and transportation to a bulk tank system on the farm and enroute to the plant was authorized and stimulated by a 1950 change in the health regulation allowing chemical sterilization of milk handling equipment on farms in place of the previous live steam requirement. (3) In 1958 the health regulation requirement that milk for the District of Columbia must come from farms holding D. C. Health Department permits became a major factor in a producer-price bargaining struggle, and clearly demonstrated the vulnerability of local cooperatives in a bargaining confrontation with a regionally integrated proprietory handler in the absence of local health department restrictions to local supply sources.

Project A-26-br



The Washington, D.C. milk marketing area, 1945.

An Economic Analysis of the Role of Farmer Cooperatives as Marketing Organizations

Marketing cooperatives provide a significant market for three important agricultural commodities in Maryland—dairy products, tobacco and grain. During the period 1957-1966, all Maryland agricultural commodities marketed cooperatively amounted to 27.5 percent of the value of all farm products marketed. Dairy products marketed cooperatively amounted to 75.6 percent of the value of all milk marketed; tobacco amounted to 27 percent of all tobacco marketed, and grains amounted to 28 percent of all grains marketed.

In attempting to analyze plans for future growth of cooperative marketing associations in Maryland, the information obtained was in general terms revealing no specific plans for expansion, mergers or acquisitions.

The major objectives of the marketing cooperatives as expressed by boards of directors and management was: (1) to increase prices for products sold; (2) to reduce prices of supplies purchased; (3) to expand and integrate facilities to better serve the members.

To benefit the farmer members, there was a strong feeling that the marketing cooperative must, where possible, market the products to the consumers as well as increase the purchasing activities of the cooperative. Service activities of the marketing cooperatives continue to expand. This business is considered necessary to the primary function of marketing and is not considered as an expansion or growth of the cooperatives.

Several areas of expansion have taken place in Maryland marketing cooperatives in recent years. Several are new ventures not yet proved—one venture into the retail field met with failure.

Cooperative officials, perhaps following good business practices, did not reveal specific plans for cooperative growth at the time they were interviewed. The cooperatives are aware of the need to be alert to all new market developments and indicate that they are interested in increasing their market advantage whenever possible.

Project A-26-bs

Evaluation of Market Structure Performance in Marketing Northeast Fruits and Vegetables

A bulletin covering the farm level plan of the project was completed and published.

Interviews were conducted with 20 first handlers and wholesalers of Maryland-produced, fresh market tomatoes, sweet corn, and green beans in Salisbury and Baltimore, Maryland; Washington, D.C.; Philadelphia and Pittsburgh, Pennsylvania. Major findings from this part of the project were:

(1) Seventeen of the wholesalers indicated that they have reduced the quantity of Maryland vegetables handled since 1960. Three of the wholesalers reported handling about the same quantity as in 1960.

(2) Sixteen of the wholesalers reported that the Maryland-produced vegetables were not graded. Because Maryland doesn't grade, growers are finding it difficult to market their vegetables in competition with other areas of the country which do grade.

(3) Services provided by wholesalers to their customers have not changed since 1960, eighteen of the wholesalers indicated.

(4) Variety recommendations are made to wholesalers by their customers as reported by 16 of those interviewed.

Work on development of the "optimum" market model for Maryland-produced fresh market tomatoes, sweet corn, and green beans was continued as more detailed data became available.

Publications:

"Farm Level Marketing of Maryland Produced Tomatoes, Sweet Corn, and Green Beans for Fresh Market, 1965," Jarvis L. Cain and Ulrich C. Toensmeyer, Misc. Pub. 636, Agricultural Experiment Station, University of Maryland, College Park, Maryland, May, 1968.

"Economies of Size in Selected Affiliated Wholesale Food Marketing Firms—1967," Jarvis L. Cain and Jack L. Runyan, Misc. Pub. 644, Agricultural Experiment Station, University of Maryland, College Park, Maryland, May, 1968.

Project A-26-bu

Economic Analysis of the Market Structure of the Commercial Fishing Industry in the Northeast

Consumer demand functions for several fishery products were estimated using single stage least squares. The lemand for most fishery products is price inelastic; income elasticities are usually less than one and are negative for some products. Oysters, the most mportant Maryland seafood product, has a price elasticity of -0.17 and a -1.21 income elasticity.

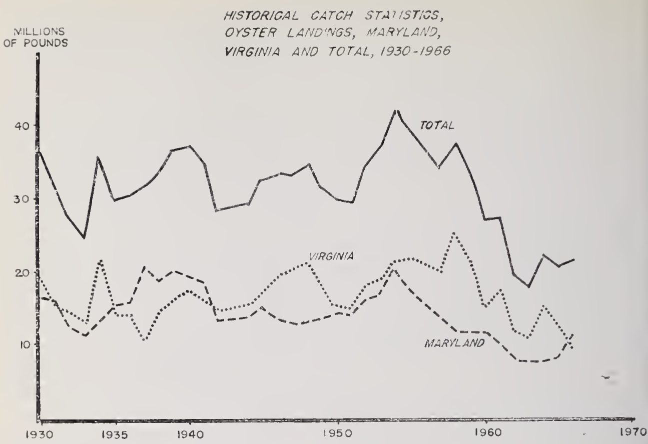
Processor level demand functions or oysters, hard-shell clams, soft-shell clams, and crabs were estimated. The esults were good in a statistical sense with most R^2's being above 0.85. However, in many cases signs of coefficients were opposite from those expected on he basis of economic theory.

In 1966 there were 135 plans—57 percent of the 237 seafood processing plants in Maryland and Virginia, involved in oyster shucking. There were 73 plants—31 percent of the total, involved in crabmeat picking.

Cost data were collected to determine possible economies of size in crabmeat picking, oyster shucking, and clam shucking operations. Piecework wages (for shuckers and crabmeat pickers) comprise over half the total cost in all cases when payroll taxes are included. Because of this, economies of size are relatively small.

Publications Issued:

R. E. Sutter, T. D. Corrigan, and W. H. Wuhrman, *The Commercial Fishing*



and Seafood Processing Industries of the Chesapeake Bay Area. Maryland Agricultural Experiment Station, Miscellaneous Publication No. 676, November, 1968.

R. E. Suttor and W. H. Wuhrman, *Employment in the Maryland-Virginia Seafood Processing Industry.* Maryland Agricultural Experiment Station. Miscellaneous Publication No. 677. December, 1968.

Project A-26-bi

An Analysis of the Feasibility of New or Reorganized Marketing Facilities in Selected Areas of Maryland

A limited study was made of possible results from reorganization, merger or integration of marketing firms of Maryland. Statistics were compiled on a number of agri-business firms operating in Maryland including the manufacturers, food processors, distributors of input items and food and fibre wholesale and retailers. This information was used in advising firms and industry groups of possibilities for future organization and success in business anticipation. A card file was developed for future use in working with certain groups in the state.

An intensive study was made of the poultry processing industry and the impact of scale in a future organization of poultry plants.

Guidelines for advising industry groups and market firms relative to market organization and structure for the future include:

1. Firms should place more emphasis

on institutional organization and business management while considering the technology of handling the physical product.

2. Greater emphasis should be given to the function and relevance of firms beyond the context of industry structure. That is, greater emphasis should be placed on macro-economic rather than micro-economic considerations.

3. Market transaction, that is, price discovery, contracting and legal forms used in doing business, must receive increasing attention.

4. In deciding on the location of market firms, specialists should constantly explore ways of extending markets for the benefit of instate clientele and interests.

5. Greater attention should be given to market power achieved from a firm's concentration with suppliers attempting to influence price and product differentiation.

Project A-26-bw

An Analysis of the Forest Marketing Structure in Maryland

From data obtained from sawmill operators in Maryland a Master of Science thesis and one bulletin were written. The bulletin, *Market Structure of the Sawmill Industry,* Misc. Pub. 645, April 1968, showed that about one-fifth of the firms in Maryland accounted for about 50 percent of the industry's $25 million annual gross sales. Most of the gross sales accounted for by sawmill operators were concentrated into rough and finished dimension stock. About one-half of the land area in Maryland is devoted to growing some type of timber.

The analysis of the data concerning woodlot owners in Maryland was initiated. A Master's thesis is being written.

Based on the response obtained from the mail survey of Christmas tree growers in Maryland, a comprehensive field study of the operation was initiated.

Project A-26-by

Structure of Maryland Grain Prices

Weekly average prices of corn, wheat, oats, barley and soybeans for five (predetermined) geographical areas have been obtained. The seasonal, cyclical and trend components of price have been computed. Cost of transportation from Toledo, Ohio (a base point) to various points in the state have been secured for rail, regulated truck carriers and point-to-point truck carriers. The available data concerning regulated transportation rates have been published for each freight rate district in the state.

A cost minimization (grain movement) model is being formulated. Also farm grain prices will be evaluated in terms of export and base point quotations by selected geographical areas in the state.

Project A-26-bz

AGRICULTURAL ENGINEERING

Agricultural engineering research is concerned with the engineering phases of developing equipment, facilities or systems for production, processing, transporting, storage, and marketing of animal or plant products. This research may be directed either toward determining the basic engineering criteria needed in design and/or for applications on the farm use or in related agricultural industry. Those efforts are directed toward reducing labor requirements and cost of production, maintaining or improving quality of agriculture products, improving handling and transportation of crops and animals, and shortening the work for more timely harvest. Therefore, mechanization is one of the more important functions of Agricultural Engineering.

Because engineering problems exist in all disciplines of agriculture, most research is conducted in copperation with scientists in other disciplines. The summaries which follow indicate this close cooperation and their efforts are recognized. There also exists both a formal and informal use of agricultural engineers as consultants on the engineering aspects of research throughout the Agricultural Experiment Station.

lechanization of Tobacco Harvest

There existed several undesirable eatures in the tobacco harvester tested luring the 1967 season. Some of these vere: need for more clearance between he shafts of the conveying belts to allow he tobacco to pass without damage; vider conveying belts and a need to levate the tobacco higher before loadng. Also, the polyurethane foam cushoning did not stand up and separated rom the neoprene belt.

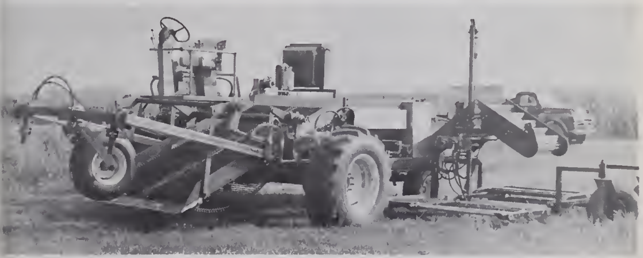
Due to these undesirable features a iew machine was constructed that corected these problems. Very satisfactory esults were obtained with damage beng held to about the same level as with onventional hand harvest. The pallet vas replaced with a 8′x16′ bed wagon vhich proved to be more desirable than ne pallets since about four times more tobacco could be moved to the barn at one time.

Tests were conducted to determine the difference in physical damage inflicted on the tobacco when mechanically harvested for ten Maryland varieties. The lowest damage occurred to Maryland 609 and Maryland 10 while the variety Gertz had the greatest damage. The large percent of damage and loss of leaves occurred to the bottom third of the plant. Also it was determined that 45 percent of plants leaves are on the bottom third of the plant. Further studies of the physical characteristics of the plants relative to mechanical damage will be helpful in the design of harvesters.

Project R-11-h

evelopment of Equipment and Improved Methods or Harvesting Sweet Potatoes

The construction of a two row self-ropelled prototype sweet potato harester was completed. Limited field ials were conducted late in the harvest season in the Salisbury, Maryland area. Due to adverse summer weather the sweet potato crop was very poor, making a satisfactory evaluation of the



Two row self-propelled prototype sweet potato harvester.

capability of the harvester impossible. However, valuable information was obtained on the function of individual components of the machine. Failure of some commercial equipment used will require additional shop testing and redesign. Detachment of the potatoes from the plant appeared to be the major functional problem. Additional delivery equipment and possibly cleaning or grading equipment may be added.

Project R-18

Development and Construction of Specialized Facilities and Equipment for Use in Agricultural Research

Equipment was designed and constructed to determine the effect of degree of agitation and time of exposure on the water absorption of freshly killed broilers during the cooling process.

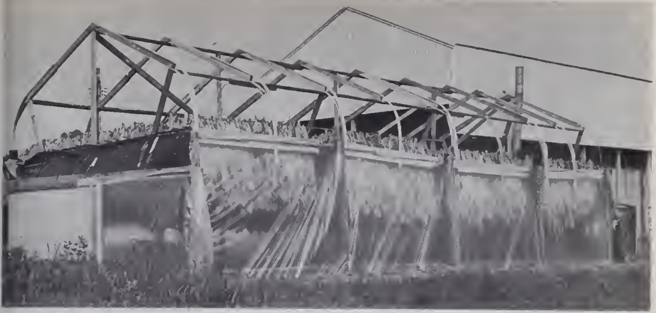
Four individual mobile plot irrigators were designed and built. These units facilitated the ease of and improved accuracy in irrigating plots in the climate study work by the Agronomy Department.

Project R-21

Tobacco Housing

All previous work on compact curing of Maryland tobacco has been at a maximum density that the tobacco could be hung. The plants were speared approximately 20 plants to a four foot stick and the sticks hung about 11 inches apart giving a density of 6 plants per square foot. These sticks weigh between 60 and 70 pounds. The physical handling of these sticks becomes a problem with complaints from the workers. In an attempt to make hanging and handling easier studies were conducted spearing 9 and 6 plants per stick and hanging the sticks as close as possible. This gave densities of 4½ and 3¾ plants per square foot of floor area.

Excellent quality was obtained for both cures. The same schedule of fan operating only during the day for 8 hours was followed. Supplemental heat was used when required. The second



Temporary plastic covered compact curing facility filled with fresh cut tobacco. Note plastic roof has not been installed.

cure started September 13 and the nights were too cool for optimum curing. The pipe burners were used to raise the temperature to 90°F at night. By keeping the facility closed, the humidity was kept at a high level and ideal yellowing was accomplished in four days. This controlled yellowing helped produce an excellent cure.

The only disadvantage of spearing less plants per stick is that the total amount of tobacco per square foot of floor area is reduced. The user of this type system of curing has to evaluate the loss of density against ease of handling for his individual operation.

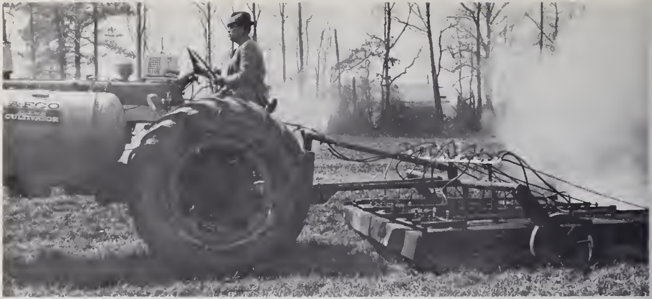
Project RB-11-g

Application of Energy for Control of Insects

The performance characteristics of he experimental flamer, using burners lesigned and constructed in the Agriultural Engineering Department, were etter than flamers with commercial urners. Good control was achieved on rst cutting yields by a dormant flame reatment at 3 mph. Flame treatments educed the percentage of weed cover. Iowever, due to wide variations in data ie results were not significantly differnt from unflamed plots.

The first cutting yields from early arvest plots were reduced. However, ie total yield for three cuttings was

Burner designed and built by Agricultural Engineering Department.



Experimental field flamer constructed with Maryland burners and used in 1968 field studies.

not lower than normal harvest plots. Plants from early harvest plots that received a dormant thermal treatment had protein contents significantly higher than unflamed plots. The difference in protein content could be caused by a change in leaf stem ratio and reduction in old residue by flame treatment.

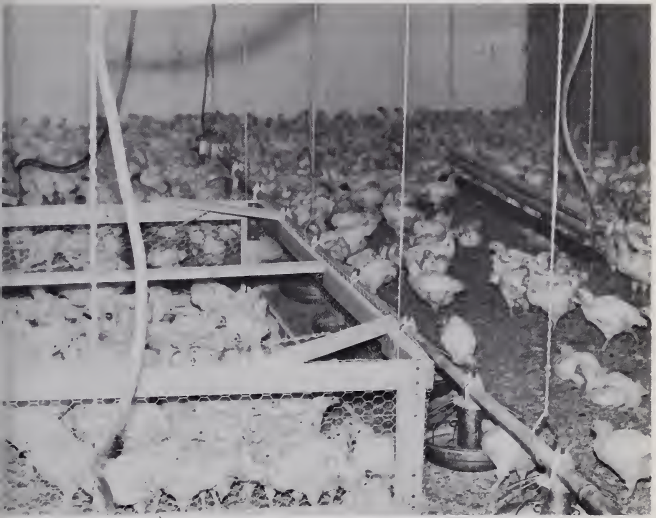
Project RHB-23

Environmental Requirements of Poultry

During the period covered in this report the facilities for environmental research were completed and dedicated in February 1968. The facilities consist of a physiological laboratory and a 40-by 200-foot structure which has 9 chambers for environmental studies. Research on starting temperatures and rates of temperature reduction will comprise the initial work. There was one flock through the facilities prior to June 30, 1968. This was primarily a "shake down" period. As would be expected in a new facility there were several things that needed attention.

NE-8, "Environmental Requirements of Poultry," under which Project RM-1 operates, was closed out as of June 30, 1968. RM-1 was closed out and replaced by RM-2 which will operate under a new regional project NE-61 "Physiological Response of Chickens to Varying Environments."

Project RM-1



Birds trapped on a false section of the floor which is suspended by four cables that have strain gage transducers installed in them. These transducers are used to determine weights of the chickens. Also shown are part of the automatic feeding system, one of the waterers and the fan controls.

AGRONOMY

The purpose of the research program in the Department of Agronomy is to develop improved crop varieties and improved soil and crop management practices that will result in more efficient crop production. Of equal importance is the development and application of principles of soil and water use and conservation. Investigations of fundamental principles of the physiology and biochemistry of crops and the nature and properties of soils are major objectives of the Department of Agronomy. Results from the basic research are applied to the practical problems of agronomic nature.

The wide range of soils and 2.3 million acres of agronomic crops—corn, soybeans, tobacco, small grain, turgrasses, hay, and pasture—grown in the state with a value of approximately 150 million dollars, emphasize the size and importance of the research program in agronomy. To solve crops and soils problems research work is conducted at the University, on the University farms, and with cooperating farmers, golf course superintendents, and others throughout the state.

Soybean Varietal Improvement

The release of two new soybean varieties, Cutler and York, highlighted the research in soybeans in 1967-1968. These new varieties have consistently outyielded the existing varieties in their respective maturity groups. Cutler is of the Group IV maturity and is adapted to most of Maryland, whereas York is of Group V maturity and is best adapted to the lower Eastern Shore.

The use of narrow rows (14 inch vs. 36 inch) in soybeans planted after barley increased the bean yield on the average by six bushels per acre in a study conducted at three locations in Maryland. In the 36 inch row width, yields averaged 27.8 bushels per acre whereas in the 14 inch row width, yields averaged 33.8 bushels per acre.

Selections for genotypes with ability to more efficiently utilize high fertility have been made in field and greenhouse studies. These selections are currently being used in the breeding program.

Project B-43

Breeding for Better Dent Corn

Exceptionally good test-plot yields were obtained on the University of Maryland Plant Research Farm in 1967. Rainfall was adequate and well distributed for corn.

A 30-entry comparison for corn hybrids at two population levels—23,200 nd 17,400 seeds per acre in 40 inch rows—had population averages of 131 nd 120 bushels of grain per acre respectively. The 11 bushel difference vas statistically significant. Only three ybrids showed differences in favor of he lower seeding rate at this level of roductivity.

In another experiment designed to rovide information on the effect of opulation level and plant spacing on roductivity, a medium-season hybrid was compared at 18,100 and 24,300 plants per acre in 40, 30, and 20 inch rows. At all three spacings the higher population was most productive. Yields in bushels paired for population levels for the respective row-spacings were as follows: 40 inch, 131-141 bushels; 30 inch, 134-153 bushels; 20 inch, 132-157 bushels. At the lower population level row spacing had little effect on yield (131-134 bushels). The higher population yields were better for all three row width but yields increased with decrease in row width.

Since all hybrids do not respond alike to the same environment, other hybrids may have responded differently to the spacings provided in this experiment.

Project B-50

Breeding of Improved Varieties of Forage Species Adapted to the Northeast

The improvement in productivity and insect and disease resistance of alfalfa through selection and hybridization is being studied. A USDA alfalfa selection, MSHp6, with resistance to the alfalfa weevil is being studied for its productivity and its feeding value. Forage yields (tons per acre) at Clarksville for the first two cuttings in 1968 were: MSHp6 (weevil resistant), 3.62; Cherokee, 3.38; Iroquois, 3.32; Saranac, 3.51; and Vernal, 3.11. MSHp6 also had fewer and smaller alfalfa weevil larvae on its foliage.

Selection for higher levels of resistance to the weevil and to *Sclerotinia* crown and root rot is being continued.

Project B-56-i

Beef Production on Midland Pastures Increased with Nitrogen Fertilization and Grain Feeding

Midland bermudagrass pastures sod-seeded with a mixture of rye and wheat for early fall and spring grazing were evaluated for a third growing season. The pastures were fertilized with 200 and 400 pounds N per acre. At each nitrogen level, grazing animals were either fed no grain or grain at the rate of 0.7 pounds per 100 pounds body weight per day. For each of the three years, individual animal performance and beef production per acre increased with both grain feeding and nitrogen fertilization. Grain feeding had the greatest influence on animal performance by increasing daily gain as well as animal grade equally well at both nitrogen levels. Although production was highest at 400 pounds N per acre with grain feeding on pasture greatest net return was at 200 pounds N per acre with grain.

Project B-56-j

Wheat Breeding and Evaluation

New wheat varieties and experimental selections compared in nurseries and field-plot tests in Maryland indicate that long-time effort to improve productivity and straw type in eastern varieties is succeeding. The influence of Norin 10, a short productive Japanese wheat introduced into the United States in 1946, is now being shown in derivatives suitable for production in eastern states. Currently, Blueboy, a derivative released from the North Carolina Agricultural Experiment Station, is performing well in Maryland tests.

In a plot comparison near College Park on Beltsville silt loam soil with medium fertilizer application, it led the test with 59 bushel per acre and exceeded check varieties, Seneca and Redcoat, by 11 and 15 bushels respectively. On the Wye Institute farm east of the Chesapeake Bay, Blueboy was compared with Benhur, Monon and Redcoat at nitrogen top-dressing levels of 0, 40, 80, 120, and 160 pounds per acre on Mattapex silt loam soil that received a pound-per-acre application of 18N, 74 P_20_5, 74 K_20 at planting time. All four varieties responded to the 40 pound increment but none showed a significant gain for additional increments. Blueboy produced 48 bushels of grain per acre at the 0 level and 66 bushels at the 40 level—a gain of 14 bushels over Redcoat, the next in line. Plant height for Blueboy ranged from 37 to 41 inches as compared to 45 to 48 inches for Redcoat. Neither variety had any lodging below the 80 pound rate. Test weight for Redcoat did not fall below 60 pounds for any nitrogen level. Blueboy varied from 57-59 with an average of 57.7 pounds. To date, low test weight appears to be the most objectional characteristic of the variety.

Project B-66

Varietal Improvement in Barley and Oats

Although much improvement has been made in breeding for winter hardiness in oats and barley, serious damage still occurs occasionally in eastern and southern Maryland. In the fall of 1967, wet soil delayed College Park nursery planting of oats until October 14 and the planting of barley until October 21—about a week later than usual. The fall and winter that followed did not tolerate late planting. Consequently, all the nursery oat plantings were lost and survival for barley selections was low—5 percent to 50 percent. The Tennessee winter check averaged 10.6 percent. Even a wheat check was down to 75 percent survival. Oat and barley drill plots planted 2 days earlier on similar soil in another field with woods protection had a survival range of 35-66 percent for oats and 52-74 percent for barley. Barley varieties, Rogers, Besbar, Zora, Wong and James produced 54 to 61 bushels per acre. Rogers and Zora were outstanding for straw quality.

Project B-67

Controlled Environment Helps Understand Plant Growth

Potomac and S-37 Orchardgrass, Climax timothy, and Dollard and Maryland Syn-1 red clover were grown in field plots where the soil temperatures were maintained at ambient, 10°C, 21°C, and 32°C. S-37 had the highest tiller development followed by Potomac and then Climax. Greatest tiller development for all grasses was at 10°C and least at 32°C. During the middle of the summer new tiller development on Climax was reduced as much in the ambient plots as at 32°C. Forage dry matter yields followed the same pattern as tiller development.

Dry matter yields of the two red clover entries were greatly influenced by temperature with 21°C being highest. However, plant survival was greatest at 10°C where all plants persisted. Above 10°C, plant survival was significantly better for Maryland Syn-1. At 32°C, no Dollard plants survived while most of the Syn-1 plants persisted at all temperatures. (See page 38, project B-97 for list of publications.)

Project B-73

Midland Bermudagrass Hay Production

Forage yields for the third harvest year of Midland bermudagrass fertilized with 0,200,400, and 600 pounds N per acre and harvested 4, 5, and 7 times have been completed. Yields leveled off at 400 pounds N per acre. Production also decreased as the number of harvests increased with five harvests appearing to be near optimum with regard to forage yield and quality. When fed, forage dry matter intake and digestibility were both increased with frequent harvesting. Nitrogen fertilization also increased dry matter intake but appeared to have little effect on digestibility.

Residual nitrogen carryover in the soil was not as great at this location as was found in previous studies. High nitrogen fertilization, and to a lesser degree frequent harvesting, resulted in less weed infestation.

Project B-74

Forage Production Improved with Sod-seeding

Forage production of permanent bluegrass pastures was significantly increased by sod-seeding crownvetch and birdsfoot trefoil. The production from crownvetch increased each year, while yields of trefoil were about constant and those from completely renovated areas decreased. It took 200 pounds of nitrogen per acre to equal the production obtained from sod-seeded crownvetch.

Midland bremudagrass was sod-seeded with cool-season annuals and perennial species. Yields with the annuals (rye or rye-wheat mixtures) were about one ton more than for the perennials (Ky-31 tall fescue or Potomac orchardgrass). Hairy vetch seeded with the rye-wheat increased yields by 0.6 tons. Forage yields of Midland and the sod-seeded crops leveled off at 400 pounds nitrogen per acre.

Project B-75

Red Clover Breeding Investigations

Seven new red clover synthetic varieties were made in 1967-68. These synthetics and five standard red clover varieties were seeded in a small plot study at Clarksville in May 1968. The forage yields of the seedling year harvest indicated three of the new synthetics were similar in yield to the Kenland variety and superior to Chesapeake. The yields ranged from 1.25 to .65 tons D.M. per acre. These synthetics are composed of parental clones selected for their superior persistence and vigor under Maryland conditions for 12 years.

Data were obtained on persistence, vigor and insect and disease resistance on 200 plant introduction lines of red clover from a study seeded in the fall of 1967 at Clarksville. This study will be continued until the spring of 1970 when final selection for persistence will be made.

Project B-76

Forage Crop Variety Evaluation

Evaluation of fifteen alfalfa varieties over the past several years showed Pioneer X583, Saranac, Du Puits, and Williamsburg to be highest yielding. Preliminary data from an alfalfa weevil management study has shown Team to be equal or superior in yield to Cherokee, Iroquois, Saranac, and Vernal. In addition it showed considerably more tolerance to the alfalfa weevil.

Four varieties of crownvetch—Penngift, Emerald, Chemung, and Ky-63—were evaluated following seeding into a Midland bermudagrass sod. Differences between varieties were small with Chemung being highest and Ky-63 being lowest.

Project B-77

Use of Herbicides to Control Weeds in Forages

Chickweed control has become a major problem in alfalfa. Dense populations can adversely affect alfalfa yields and quality. Fall application of diuron, simazine, chlorpropham, terbacil, and dicamba resulted in 90 percent or better chickweed control. However, spring applications were not as effective. A fall and spring application of diuron at 1.5 pounds per acre and fall applied simazine reduced alfalfagrass yields. Diuron formulated on fertilizer was as effective as spray formulation. Although a 33 percent vigor reduction was recorded from diuron formulated on fertilizer, yields were not effected.

Dichlobenil and terbacil proved too injurious at 1 pound per acre and 0.4 pound per acre respectively which reduced yields. Dicamba almost completely eliminated the alfalfa.

Fall applications of simazine, diuron and chlorpropham were quite effective in controlling chickweed. Terbacil and dichlobenil reduced yields while dicamba almost completely eliminated alfalfa. Diuron formulated on fertilizer was as effective as a sprayed treatment.

Project B-79

Late Planting and Winter Survival in Oats

If planted early enough in the fall in central and eastern Maryland on suitable soils with proper fertilization, winter oats is a productive crop. Although breeders have made progress in selecting for winter hardiness, oats still need to be planted a week or more earlier than barley—a serious limitation in important crop rotations.

In order to obtain information on the relationship between time of planting and cold tolerance, winter survival, heading date, and productivity, seven varieties were compared in a replicated nursery for three planting dates: October 1, 10, and 20, during a 6 year period. The nursery was located on Sassafras loam soil near College Park. Varieties included were Cimmaron, Early Wintok, Wintok, LeConte, Dubois, Ballard and Nysel. Due to weather conditions at planting time only 5 seasons provided comparable results. Occasionally at this loation an early freeze may seriously damage plantings made after October 10. In 4 of 5 years all plantings had 90 to 96 percent survival. On poorly drained silt loam soils survival would be lower. Relative yields of grain for the three planting dates were 100, 90, and 71. Factors other than survival contributed to drop in yield for the last two plantings. Inadequate fall growth may have been responsible.

On the basis of test-period averages the varieties did not differ greatly in plant survival. All had adequate stands.

Artificial freezing of plants grown in flats (1964-65) indicated that October 1 and 10 plantings developed adequate winter hardiness and that maximum hardiness was developed by mid-December.

Although the varieties used differed in relative survival and productivity from year to year, all appeared limited in planting to the October 10 date.

Project B-85

Evaluating the Effects of Some Factors Known to Contribute to Maximum Production of Maryland Tobacco

Tobacco yields of nearly 4,000 pounds per acre of cured leaf have been achieved in burley area. However, Maryland has had to be content with about 2,000 pounds per acre or less if quality is to be maintained. The market demand for a light colored Maryland tobacco requires a strict limitation on nitrogen supply, as compared with burley. The fluffiness (low bulk density)—a unique quality much desired by the trade—can only be obtained with complete ripeness and a low level of nitrogen.

There is, however, a definite but narrow range of nitrogen fertilization within which both yield and quality rise. Roughly, this range is from 60 to 90 pounds per acre of fertilizer nitrogen. Below 60 pounds, yields suffer and the leaves are uneven in color and tend to have a bitter taste. With applications of more than 100 pounds of nitrogen, yields continue to increase, but the cured leaves are darker in color and have a less desirable aroma.

In 1967, a group of standard varieties and breeding lines were grown under nitrogen rates ranging from 30 to 120 pounds per acre, following a tall fescue sod. An interaction between nitrogen rate and variety was found for yield and acre value, but not for price per pound. Filling capacity (bulk density) was significantly correlated with variety and leaf area and negatively correlated with alkaloid and total nitrogen contents.

Project B-87

Physiological Relationships of Tobacco to Cultural, Fertilization, Curing and Fermentation Practices

In 1967, samples of cured tobacco were obtained from farmers in the five Southern Maryland counties. The samples from Charles County were highest in total nitrogen but lowest in alkaloids. Those from Calvert County were lowest in total nitrogen and second lowest in alkaloids. The samples from the other counties were all higher in alkaloids by a small amount but all were highly acceptable with 2.66 percent being the highest average.

Seven Maryland varieties and nine advanced breeding lines were grown in three locations in a replicated test. Alkaloids and total nitrogen contents were higher at Upper Marlboro, Prince George's County than at Davidsonville, Anne Arundel County, or Dentsville, Charles County. Again, all were acceptable. Duration of burn was markedly better at Davidsonville than at the other two places. Filling capacity did not differ greatly at the several locations but differed significantly among varieties in each test as did the duration of burn.

Project B-89

Effects of Physical Characteristics of Herbicides on Efficiency and Mode of Action When Used on Corn and Soybeans

Vapor losses of some herbicides can be an important unwanted loss. The volatility of sprayed application of trifluralin (Treflan) was approximately 25 percent and for benefin 12.5 percent at 122°F (50°C) from a Lakeland loamy sand soil at field capacity under controlled laboratory conditions. Meanwhile, nitralin's (Planavin) volatility was negligible. Decreasing soil cation exchange capacity and increasing soil moisture from air dryness to field capacity increased volatility. However, increasing soil moisture above field capacity did not increase volatility.

A granular formulation of trifluralin was effective in reducing vapor losses, but volatility of a granular formulation of benefin (BALAN) was similar to the spray application.

Increased spectrum weed control was observed with many of the herbicide combinations investigated in corn. Butylate (SUTAN) 3 pounds per acre or butylate plus atrazine 3 pounds per acre plus 1 pound per acre respectively, were the only herbicides preplant incorporated to result in acceptable nutsedge control. This combination and other herbicides with alachlor (LASSO)

Nutsedge and weed control resulting from atrazine (AAtrex) plus butylate (SUTAN) two months after preplant incorporation with no cultivation.

were effective on fall panicum. Butylate preplant incorporated plus atrazine with oil postemergence was the only combination which was synergistic for nutsedge control. In soybeans, chloroxuron (TENORAN) postemergence effectively controlled ragweed which escaped trifluralin, nitralin, and vernolate (VERNAM).

Project B-94

Control of Johnsongrass From Seed and Rhizomes

Johnsongrass is an extremely difficult to control perennial weed. The three tillage methods—spring tooth, rototiller, or disk—in repeated fallow cultivation resulted in greater than 90 percent Johnsongrass rhizome death by September. Rototilling was most effective in reducing the rhizome length and carbohydrate reserves.

In another experiment, Johnsongrass was successfully controlled while growing a soybean crop. Cultivation was needed in addition to dalapon preplow for rhizomous Johnsongrass control plus either vernolate or trifluralin preplant incorporated for seedling Johnsongrass control.

Finally the use of repeated applications of foliar herbicides such as MSMA and dalapon at 3 and 4 pounds per acre were very effective in controlling Johnsongrass. Paraquat plus dalapon resulted in rapid kill but Johnsongrass recovered. Soil sterilants such as Promitol, Atlacide, and bromacil proved effective.

Project B-95

Johnsongrass control resulting from 3 lb/A of MSMA applied twice. First application was made to actively growing Johnsongrass, and a retreatment made as the Johnsongrass began active growth following the second treatment.

Investigating the Agronomic Feasibility of Transplanting Tobacco Seedlings in Pressed Peat-Soil Cubes

Results showed that tobacco seedlings grown in pressed peat-soil cubes were agronomically feasible in transplanting. The main advantage was that labor at peak demand period during transplanting was reduced by 50 percent. It was also shown that there were no significant differences in acre returns between the plants grown in cubes and conventional plants. Uniformity measurements indicated that plants grown in cubes were somewhat more uniform than conventional plants. Methods were developed enabling the production of cubes at the rate of 2700 per man hour and seeding with pelleted seed at 6000 per man hour. This work presents a definite mechanization potential that isn't available with conventional plants or the standard transplanter of today.

Project B-96

Red Clover Management

Red clover and red clover-timothy mixtures were compared at two locations with three fertility levels, three harvest schedules, and two seeding dates. Although red clover responded to fertility, this response was not as great as that reported for alfalfa. Early harvesting resulted in increased quality without loss of stand or forage production. Timothy increased yields and reduced weeds. In a third experiment red clover was compared with alfalfa and pure grass stands. In the first harvest year, red clover yields were within 0.33 tons of that obtained from comparable alfalfa treatments. However, red clover was not competitive after the first full harvest season.

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Project B-97

Physiological and Biochemical Mechanisms of Selectivity of Herbicides

Trifluralin is widely used for soybean weed control but very little is known about what happens to trifluralin inside weeds and soybeans. Laboratory research on the selective mode of action of trifluralin is being conducted with radioactive trifluralin. Preliminary investigations have shown several breakdown products of trifluralin in soybeans and weeds. Trifluralin-treated soybeans utilized less water than untreated soybeans. Further work is being pursued in order to elucidate the selective mode of action of trifluralin.

Project B-98

Light grain feeding on pasture result in higher daily gain plus a higher slaughter grade at the end of the season. All animals were grazed on pastures fertilized with 200 lbs. N per acre. Those on the top were fed grain.

Plant measurements being made in climate study. Cart allows experimenter to work over plots without disturbing the plant. The third man is recording measurement data.

Factors Related to Irrigation of Tobacco

Rainfall was nearly adequate during the 1967 growing season. Only June with 1.29 inches was definitely inadequate. The latter half of July with only 0.67 inch led to retarded plant development. "Second growth" followed heavy August rainfall.

A single irrigation did not change the crop response, as yield, value per pound and acre return was identical with or without added water. The Wilson variety outperformed Catterton in yield and acre value. There was a yield response to nitrogen fertilization but no increase in acre value.

The late spurt in growth resulted in very high levels of nitrate nitrogen in the cured leaf. This was correlated with dark greenish colors of the leaf.

Project B-99

The Effect of Modified Cultural Practices and Environmental Control of Curing Upon the Adaptability to Mechanization and Quality of Maryland Tobacco

Harvesting procedures were varied to determine effect of maturity upon yield, price, and acre values of cured tobacco leaf and adaptability to mechanization. Harvesting under the system of topping at time of cutting gave optimum response when completed in less than 71 days after transplanting. The reduction in yield and competition from flower heads and suckers suggest that this system has no potential in future mechanization programs. In a system where topping was completed well in advance of harvesting, the uniformity of quality among leaves on a stalk was improved by harvesting at 71 through 77 days after transplanting. There was less difference between leaf qualities from the bottom of the stalk through the topmost leaves which resulted in a plant better adapted to mechanization. Quality at earlier harvest dates was affected by immaturity in the top of the plant. Conversely, quality and yield were reduced in the lower leaves of the plant because of overmaturity in the later harvest dates.

Project B-101

Tobacco Breeding, Testing and Quality Evaluation of Maryland Tobacco

Replicated variety trials were conducted at three locations in Southern Maryland to study the responses of varieties and breeding lines to different soil and climatic conditions. Breeding lines with disease resistance were evaluated and compared with the standard varieties.

The highest yielding variety in the variety trials during summer 1967 was Wilson with an average of 1,991 pounds of cured leaf per acre. A Wilson-type breeding line (J-66-125F-2) was quite similar to Wilson in yield with 2,007 pounds of cured leaf per acre. Superior quality, as measured by price per pound, was found in Md. 609 and Md. 59 which brought 69.7 cents and 67.3 cents per pound respectively.

Considerable variation was found among the varieties and breeding lines in the trials for the other agronomic and physical characteristics measured. For certain traits the breeding lines were equal to the standard varieties in one or more characteristics.

For many years, tobacco farmers in Southern Maryland saved their own seed from year to year. Therefore, a considerable number of farmer selections arose over a period of years. A study was undertaken in 1967 in order to determine the amount of variability present in a small number of Catterton-type farmer selections. And, if adequate variability was present, how could it best be used in a breeding program.

Six farmer selections were chosen for this study and the Catterton variety was included as a check. The six selections originated from Prince George's, Calvert and Charles Coutnies. Catterton and the six farmer selections were grown in a replicated experiment in 1967 at two locations.

In general, essentially no useable variation existed among the six farmer selections tested. Also no selection appeared superior to Catterton, particularly for quality as measured by price per pound. Therefore, from these results, it appears that genetic variation must be obtained from some other source.

Project B-103

Tufcote Bermudagrass—Adaptations and Requirements for Turf Uses

Tufcote bermudagrass (*Cynodon dactylon,* L.) requires several applications of nitrogen per year, distributed through the May to September growing season, for best performance. Even the ureaform source of nitrogen which releases available nitrogen throughout this season does not provide satisfactory growth from a single application in spring at rates up to 9 pounds per 1000 square feet. All sources of nitrogen—ureaform, natural organic and urea—gave best results when applied at low rates at monthly or bimonthly intervals.

Overseeding studies show that annual ryegrass overseeded into Tufcote in early fall gave better fall turf coverage than any other cool-season species studied but it disappeared earliest in spring. Tall and red fescues and colonial bentgrass produced reasonably good fall turf and good spring turf. Kentucky bluegrass produced almost no fall cover but very good spring coverage.

Frequent mowing—two or three times per week—at a 1 inch height, gave excellent quality turf. In previous years, the ½ inch height was better, but in later years the turf was poorer than at the 1 inch height. Less frequent mowing (7 or 14 day intervals) and/or taller mowing produced less desirable Tufcote turf.

Project B-104

Management of Kentucky-31 Tall Fescue for Park, Playground and Athletic Field Turf

Turf composed primarily of tall fescue continues to gain in popularity for use on heavily used areas. In research studies, tall fescue-Kentucky bluegrass mixtures have performed better under simulated player use than has tall fescue, tall fescue-red fescue mixtures or a tall fescue-bentgrass mixture. The optimum seeding rate for tall fescue was about five pounds per 1000 square feet combined with one pound of Kentucky bluegrass. In the tall fescue-Kentucky bluegrass mixtures, Merion, Windsor and a Merion "common" mixture have been about equal, with all being better than the tall fescue "common" Kentucky bluegrass mixture. Merion and Windsor have tended to dominate the tall fescue at the lower mowing height (1½ vs. 2½ inches). But they still provided the best turf under heavy traffic conditions. All turf has been more seriously injured by traffic at the lower mowing height than at the taller height. Tall fescue alone, tall fescue-bentgrass mixtures have been virtually wiped out by close mowing and heavy traffic.

Project B-105

Factors Affecting Turf Quality and Rate of Maturity of Bluegrass-Red Fescue Sod

Differences in sod and turf qualities due to seeding rates (50 vs. 100 pounds per acre) virtually disappeared by the time the turf was about a year old. Nitrogen rates (132 vs. 264 pounds per acre per year) have caused noticeable differences only during the first few weeks after each application when the turf with the 264 pound rate was slightly greener but it required less force to tear the sod pieces—less tensile strength. Mowing heights now are the predominant factors. Heights of 1, 2 and 3 inches have been maintained since the turf was six months old. Number of shoots per square inch has decreased gradually at the 2 and 3 inch heights as the individual plants became larger. The number of shoots fluctuated considerably at the 1 inch height but has generally increased. Sod strength has been greatest at the 3 inch height. Rhizome growth increased with age of the sod at all heights, but growth increased much faster at the 2 and 3 inch heights.

Weed invasion has been strikingly different at the three mowing heights. This is demonstrated in the table below which shows the number of broadleaf weeds present at each height when the turf was 18 months old.

Average Number of Broadleaf Weeds* Present In Turf Cut at Three Mowing Heights

Mowing Height	Weeds per 100 sq. ft.
1 inch	42.3
2 inches	2.5
3 inches	0.2

* Weeds were predominantly dandelion and plantains.

Project B-106

Effectiveness and Residual Properties of Several Herbicides Used in Turfgrass Areas

Evaluation of promising new herbicides for annual grass control in turf is continuous and on a regional basis. Of the currently available and promising new herbicides for crabgrass (*Digitaria spp.*) and goosegrass (*Eleusine indica*) control, DCPA and bensulide continue to give good results, especially on crabgrass. Bandane and tricalcium arsenate gave good weed control but had some adverse effects such as stunting and wilt susceptibility on desirable grasses. Benefin has consistently controlled weeds poorly when used at the recommended rate.

In herbicide persistence studies on Kentucky bluegrass-red fescue turf, the percent of red fescue present has been greatly reduced by yearly applications of bandane, D-263, DCPA, terbutol, tricalcium arsenate and nitralin. Turf in plots treated with terbutol and D-263 has been quite susceptible to wilting in drought periods. Both of these are strong root inhibitors. Bandane and tricalcium arsenate have caused noticeable stunting in early spring and the latter has caused considerable turf loss during summer months during stress periods.

Project B-107

Conversion of Climatological Data to Magnetic Tape

The entire weather data from the following Maryland weather stations have been updated and edited for storage on magnetic tape. The stations so processed are Catoctin, Mt. Park, Chewsville-Bridgeport, Clarksville, Crisfield, Elkton, Emmittsburg, Frostburg, Glen Dale, Hagerstown, Millington, Monrovia-New Market, Oakland, Unionville, Upper Marlboro, Westminister, Wye Institute, and the State Sanitarium.

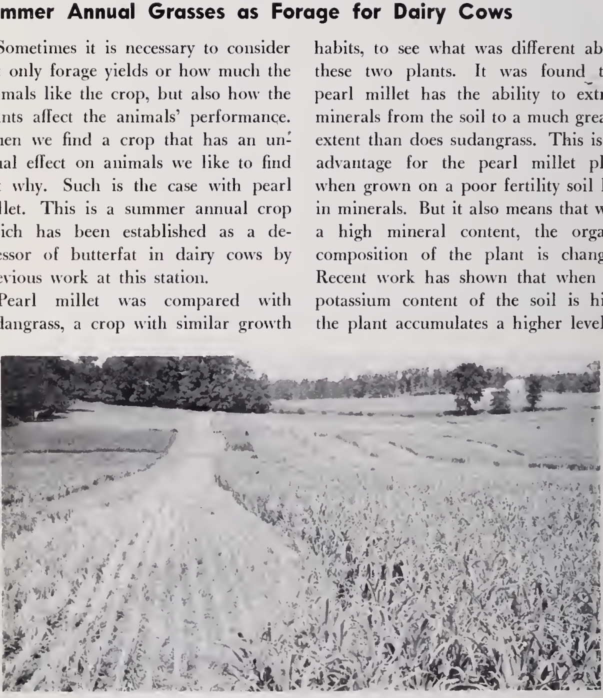
Programs have been written for the IBM 1401-7094 and UNIVAC 1108 system to be used at the University of Maryland Computer Science Center for the editing of weather data.

Project B-110

Summer Annual Grasses as Forage for Dairy Cows

Sometimes it is necessary to consider not only forage yields or how much the animals like the crop, but also how the plants affect the animals' performance. When we find a crop that has an unusual effect on animals we like to find out why. Such is the case with pearl millet. This is a summer annual crop which has been established as a depressor of butterfat in dairy cows by previous work at this station.

Pearl millet was compared with sudangrass, a crop with similar growth habits, to see what was different about these two plants. It was found that pearl millet has the ability to extract minerals from the soil to a much greater extent than does sudangrass. This is an advantage for the pearl millet plant when grown on a poor fertility soil low in minerals. But it also means that with a high mineral content, the organic composition of the plant is changed. Recent work has shown that when the potassium content of the soil is high, the plant accumulates a higher level of



Pearl millet under harvest management to study butterfat depression.

succinic acid and oxalic acid than soil potassium is low. Dry weather conditions also cause the plant to have higher levels of these acids than wet soil conditions. When cows are fed pearl millet containing high levels of oxalic and succinic acids, the butterfat is depressed. The reason for this is not known but work is continuing to study the effect of oxalic and succinic acids on butterfat depression.

Project BG-2

The Response of Corn and Alfalfa to Fertility and Irrigation

A recent innovation in crop irrigation is the use of perforated plastic pipe buried in the soil to a depth of one foot and spaced three to five feet apart. This system allows sub-surface irrigation water to applied in the root zone of a crop. Such a system can be permanently installed and there is no problem later in moving pipes as with other systems. Advocates of this system also claim there is less loss of water through evaporation into the air than with overhead systems.

Installing plastice subirrigation pipes.

Overall view of irrigation system.

In this work the sub-irrigation system was compared to a conventional irrigation system. Corn yields were increased with both systems by approximately 20 bushels per acre over non-irrigated plots. However, sub-irrigation was detrimental to alfalfa. The soil tended to be saturated close to the pipe and too dry between the pipes. Thus, the plants close to the pipes were suffering from too much water around the roots while the plants halfway between the pipes were under drought conditions. Further work is needed to see if overwintering will firm the soil around the pipes to promote better moisture distribution over the entire soil area.

Project BG-3

Development of Improved Strains of Maryland Tobacco Resistant to Disease

At the present time, tobacco mosaic appears to be the most destructive disease in the production of Maryland tobacco. Resistance to tobacco mosaic has been found in *Nicotiana glutinosa*, a wild relative of cultivated tobacco, and is presently being incorporated into several Maryland varieties and breeding lines. In the variety trials this year several Catterton-type breeding lines which have been developed by the USDA showed good mosaic resistance in addition to exhibiting good levels of yield and quality.

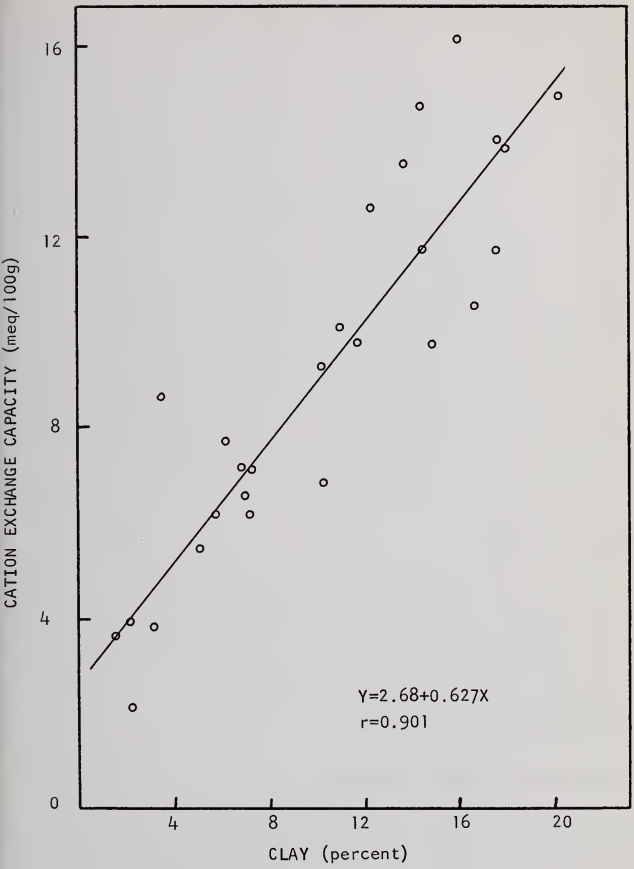
Black shank resistance from Md. 59 and Md. 609 also is being incorporated into new breeding lines along with mosaic resistance. Combining the high quality and black shank resistance of Md. 59 and Md. 609 with mosaic resistance and the high yielding ability of certain superior breeding lines should produce a very desirable variety.

Project J-95

Contributions of Clay and Organic Matter to the Cation-Exchange Capacity of Maryland Soils

Sixty modal profiles representing 20 soil series from the three physiographic regions of Maryland were described and sampled. The relative contributions of clay and organic matter to total cation-exchange capacity (CEC) of various horizons were measured using multiple regression analysis. The independent variables were clay and organic matter with the dependent variables being CEC by sum of cations and ammonium saturation. The two methods of determining CEC were highly correlated ($r = 0.90$). The average CEC of the organic matter was calculated to be 295 and 174 meq/100g by the sum of cations and NH_4OAc methods, respectively, while that of the clay was 41 and 27 meq/100g. Regression equations indicated that the mean relative contributions of clay and organic matter to total CEC of surface horizons were essentially equal. Soils of the Coastal Plain exhibited higher correlations between variables than Piedmont or Appalachian soils. Correlation coefficients of clay and organic matter with CEC in the Coastal Plain Ap horizons were 0.90 and 0.74 respectively, and 92 percent of the variation in CEC could be attributed to these components.

Project O-48



Relationship between percent clay and cation-exchange capacity by sum of cations in Ap horizons of soils developed in the Coastal Plain region.

Clay Mineralogy of Maryland Soils

Information on the clay mineralogy of Maryland soils has been summarized in the form of a state map. The map is based primarily on the distribution of kinds of soils represented by 20 soil profiles for which clay mineral analyses have been made by X-ray diffraction. Definite regional patterns in the distribution of clay minerals were revealed. Within the Coastal Plain the clay mineralogy was quite uniform, except for the soils developed in glauconitic sediments. The non-glauconitic clays contained a variety of poorly crystalline minerals that result from acid weathering. Clay of glauconitic soils (which occur in a belt between Washington, D. C. and Annapolis) contains glauconite, some montmorillonite and vermiculite, and less kaolinite than the other Coastal Plain soils. Clays from the Piedmont soils are more kaolinitic than the clays from the other regions. Also, some gibbsite was detected in the "older" Piedmont soils. Thus, the clays in the Piedmont soils generally represent a higher degree of weathering than those in the soils of the other regions. Clay of soils developed from shales and limestones in the Appalachian region were found to be quite micaceous (or illitic). The soils developed from metabasalt (greenstone) in the Middletown Valley have very reactive clay as shown by the high contents of vermiculite and montmorillonite. Throughout the state there is an increase in chlorite and a decrease in the crystallinity of the clays with approach to the soil surface. This apparently has resulted mainly from the development of aluminous interlayers in the expanding 2:1 layer clays (vermiculite and montmorillonite) during soil formation.

Project O-54

Soil Test Studies

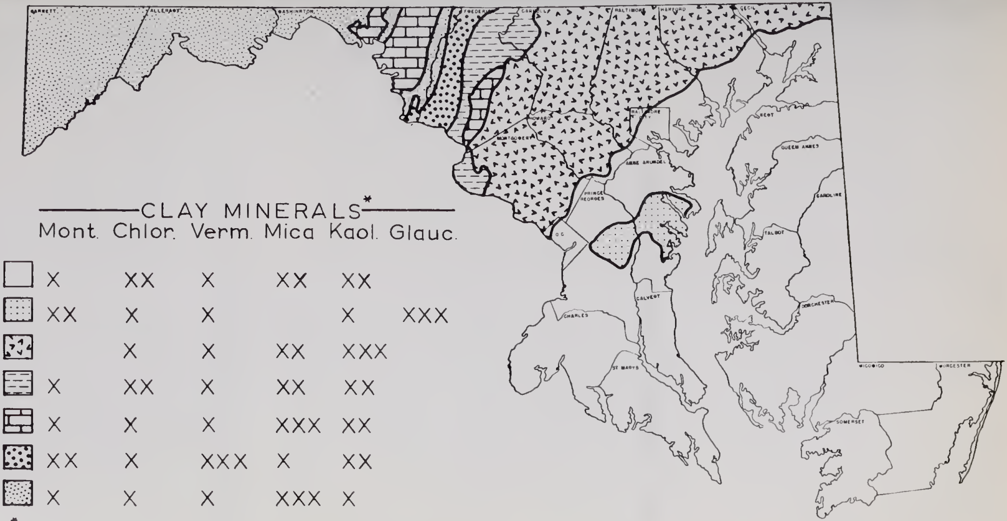
The rate at which limestone reacts with a soil has been considered by many others to be a constant in their mathematical calculations. A study of the reaction rate of limestone surfaces with soils was found to decrease with time. In one of the soils investigated the decrease in reaction after 30 days was 1/5 of the original rate. In other soils decreases occurred, but seldom of the same magnitude. These findings show that the present theoretical limestone reaction equations can give erroneous results.

Project O-55

Effective Use of Soil Nitrogen

A field experiment using N^{15}, a heavy isotope of nitrogen, to determine the amount of applied fertilizer nitrogen used by corn, the amount lost from the soil annually, and whether placement between rows or around the corn plant is best was planned for 1968-69. Experiments using N^{15} are normally very costly. However, by the use of a new design developed by Maryland and the USDA the cost of the experiment was reduced more than 300 fold.

Project O-57



CLAY MINERALS*

	Mont.	Chlor.	Verm.	Mica	Kaol.	Glauc.
☐	X	XX	X	XX	XX	
░	XX	X	X		X	XXX
▧		X	X	XX	XXX	
▤	X	XX	X	XX	XX	
▦	X	X	X	XXX	XX	
⁘	XX	X	XXX	X	XX	
▒	X	X	X	XXX	X	

*Approximate Percentages:
X 0-10%; XX 10-30%; XXX 30-70%

Distribution of clay minerals in A and B horizons of soils in Maryland (Preliminary study by D.S. Fanning and J.E. Foss, 1968).

Micro-Nutrient Requirements of Corn

Previous research has shown that micro-nutrient and secondary nutrient deficiencies can and do occur in Maryland.

Corn yields and lodging characteristics are influenced by sugar transportation and accumulation within the corn plant. For example, corn stalks which will lodge have higher levels of reducing sugars than those that stand. It is well known that the absence of some micro-nutrients result in disturbance of sugar movement in plants.

A field experiment was conducted on newly cleared land on the eastern shore of Maryland to determine the influence of micro-nutrients on stalk rot and lodging. The results for the experiment showed that the micro-nutrients applied to the soil did not reduce the lodging of the corn.

Project O-62

Effect of Nitrogen, Phosphorus, and Potassium on the Growth and Development of Forage

Alfalfa is an important source of livestock forage for Maryland farmers. But poor management can make alfalfa an expensive crop. To compete successfully with other crops, stand longevity is important. Hundreds of acres of alfalfa are lost each year because of diseases and winter-killing. Past research has shown that adequate fertilization does much to help alfalfa plants to resist disease injury and winter killing.

To learn more about how fertilization might alter a plant so that it can withstand adverse environmental conditions, alfalfa was grown in the greenhouse under several levels of phosphorus and potassium fertilization. The roots and tops were harvested and checked for phosphorus and potassium uptake, root size, xylem vessel size and number. Phosphorus and potassium increased root diameter, xylem vessel diameter, and number of xylem vessels. It is believed that larger roots will be more resistant to physical heaving of the plants. A more developed xylem vessel system in the root may possibly contribute to reduced freezing injuries to individual cells and subsequently to greater stand longevity.

Project O-64

Nutrient Balance in Orchardgrass as Related to Differential Fertilization

Yield of orchardgrass and nutrient uptake was studied where various rates of phosphorus, potassium and magnesium were applied. Application of 46 pounds per acre P_2O_5 increased yields from 2.8 to 3.9 tons per acre from four cuttings of orchardgrass. Application of potassium increased the potassium as well as phosphorus uptake indicating that applied fertilizers can result in increased uptake of other soil nutrients. No response to added magnesium was noted since the soil magnesium levels were sufficient.

Project O-71

Response of Corn to Fall vs. Spring Plowing, Broadcast vs. Plow-down Fertilizer, and Fall vs. Spring Fertilization

Many corn growers and representatives of the fertilizer industry, in an effort to utilize time, labor, money, and machinery more efficiently are becoming increasingly interested in fall fertilization for corn the following spring. Comparisons between fall and spring application of urea, ammonium nitrate, ammonium sulfate, and sodium nitrate were conducted at three locations in Maryland. In general, grain and silage yields were not affected by nitrogen source or by time of application. There was very little response to nitrogen. Residual soil nitrogen was apparently sufficient to mask any initial leaching losses. Yields were reduced slightly on one soil type because of fall plowing, whereas they were increased slightly on another.

Project O-75

Effect of Fall and Spring Plowing on Soil Moisture, Soil Aggregate Stability and Corn Yield Under Various Cropping Systems

Fall plowing did not increase corn yield or soil aggregation in 1967 in eleven cropping systems on Beltsville silt loam soil. Average corn yields were 149.8 bushels for the fall plowed plots and 148.9 bushels for the spring plowed plots. Soil aggregate stability was 15.3 percent in the fall plowed plots and 16.5 percent in the spring plowed plots. These results which are the first year's data do not indicate that it is desirable to fall plow land for corn because of the erosion hazard which is usually increased greatly on plowed land.

Project O-76

ANIMAL SCIENCE

The Department of Animal Science conducts research to improve the economic and esthetic usefulness of cattle, horses, sheep, and swine. As the consumer's tastes and desires for red meat change and as recreational and biomedical uses of these animals increase, research information is needed to meet these requirements. Livestock producers are constantly adopting new information to produce animals that efficiently provide products that match the requirements of our modern society. The Department's research projects in breeding, management, nutrition, and physiology are oriented around producing a more desirable, minimally priced product for the consumer at a level of efficiency which provides a profit for the livestock producer.

The Effects of Roughage Preparation

Previous studies on this project have shown that silage quality as indicated by animal performance could be related to dry matter intakes. Investigations of forage palatability as affected by maturity and moisture content at ensiling and relative to chemical composition of the resultant silages, have been conducted. Early cut alfalfa (prebloom), early cut Sudan grass-sorghum (Sweet Sioux, prebloom), and corn (dent stage) were harvested and preserved in plastic bags or "miniature" silos.

All the silages appeared to be of good color and satisfactory aroma. Alfalfa silage had higher pH values than did the Sweet Sioux or corn silages. The pH of silages was directly associated with nitrogen content and inversely related to sugar-protein ratios in the fresh forages—a situation which reflects the limited fermentation and consequent acid formation in forages with low sugar-protein ratios.

Wilting of the fresh forages increased crude protein and sugar contents and slightly decreased acid-detergent fiber (ADF) in the dry matter. Wilted silages contained lower levels of lactic acid and of total volatile fatty acids (VFA) than did direct cut silages. Feeding trials were conducted with sheep. Results indicated that silages preserved for 60 days were more palatable than 30 day silages and that wilted silages were superior to direct cut silages. There were, however, no significant differences in chemical composition between samples taken 30 and 60 days after ensiling.

In feeding trials conducted with alfalfa and Sudan grass-sorghum silages, wilted silages were superior to hays or direct cut silages. Adding corn cobs in a 4 to 1 ratio by weight at the time of ensiling gave good results relative to dry matter intakes and daily gains. Weight gains were significantly correlated with dry matter intakes but dry matter consumptions were not significantly related to pH, to ammoniacal nitrogen in dry matter or to lactic or acetic acids contents of the silage dry matter. All chemical parameters are indicative of the silage fermentation and were negatively correlated with dry matter intakes. There was also a significant negative correlation between dry matter intakes and butyric acid content of the dry matter. Sweet Sioux silages resulted in higher molar proportions of acetate in the ruminal fluids of sheep than did alfalfa silages or alfalfa hay. Conversely, alfalfa silages produced higher percentages of propionate in the rumen than did Sweet Sioux silages. There were no correlations between the VFA in the silages and the VFA produced in the rumina of the ewes fed with these silages.

Project C-25a

Evaluation of Dietary Protein Sources for 3-9 Week-Old Pigs Completed

Work has been completed on the evaluation of supplemented protein sources in the diets of young pigs between the ages of 3 and 9 weeks. It was determined that a higher percentage of the dietary protein was retained as tissue protein when dried skim milk and fish meal were included in 18% protein diets. Pigs fed 18% protein diets which included only soybean oil meal as supplemented protein, required more feed per pound of gain, retained less of the dietary protein in body stores, and were fatter at nine weeks of age when chemical composition of the carcasses was determined. Chemical analyses of the diets fed showed that the 18% protein, corn-soybean oil meal diets were marginal or deficient in the amino acids lysine and methionine. Dried skim milk and fish meal additions raised these amino acids to adequate levels. Similar measurements were made to evaluate diets formulated to contain either 21% protein or 16% protein which were fed to pigs in the same range of ages (3 to 9 weeks). The differences were more marked in the case of the 16% protein diets and persisted to the end of the 6 week feeding period when the pigs were 9 weeks old. The difference in feed efficiency and protein retention were less obvious when the pigs fed 18% protein diets reached 6 weeks of age. When 21% protein diets were fed, the addition of dried skim milk and fish meal improved performance only during the first 2 weeks of the feeding period when pigs were between the ages of 3 and 5 weeks.

Project C-33, C-35, C-38

Alternating Levels of Swine Ovarian Activity Studied

The ovaries of 36 female swine were observed by surgical technique through two successive ovarian cycles. The number of eggs ovulated by the right and left ovaries were unequal in all but one case. In most instances the ovary producing the most eggs during the first cycle observed produced the lesser number in the following cycle. However, this did not occur in enough instances to project that this alternating level of ovarian activity between right and left ovary would be useful in explaing variation of litter size in swine.

Project C-34

Development of Radio-Immunoassay for Swine Lutenizing and Follicle Stimulating Hormones Initiated

The follicle stimulating hormone (FSH) and the luteinizing hormone (LH) play major roles in controlling the ovarian activity of animals. The cyclic fluctuations in the elaboration of these hormones from the pituitary gland at the base of the brain place the final limit on the number of eggs produced in a particular reproduction cycle. They are of special interest in swine since variability in ovulation rate is a major determining factor in the economically important litter size performance of females. The levels of LH and FSH circulating in the blood which are effective on the ovary are extremely low. Consequently, the quantitative measurement of these hormones by ordinary chemical techniques is impossible. However, the radio-immunoassay which involves radio-isotope techniques and antigen-antibody reactions can be used to quantitatively measure the very low levels of LH and FSH. This is possible because the LH and FSH hormones are protein compounds. This assay development has progressed sufficiently to enable measure-ment of circulating LH under various reproductive conditions. This work is now in progress. The assay for FSH still needs refinement to permit routine quantitative measurement of circulating levels.

Project C-34

Further Studies of the Influence of Protein on Growth and Carcass Characteristics

Previous work at the University of Maryland has indicated that the inclusion of dried skim milk in corn-soybean oil meal diets for early-weaned pigs promotes more rapid and efficient gains during the growth period from 3 to 9 weeks of age. It has also been shown in some experiments that this early influence is also reflected in leaner carcasses when the animals are slaughtered at 200-210 pounds following standard dietary treatment subsequent to the starter requirements. Two experiments have been completed to evaluate longer periods of dried skim milk supplementation. In addition to the previous 6 week supplementation, groups of pigs were fed supplemental dried skim milk at 15% of the diet for 9 weeks and 12 weeks. The additional 3 weeks or 6 weeks of supplementation did not further improve rate of gain, feed efficiency or carcass measurements at slaughter.

The influence of early dietary treatment on subsequent performance on growing and finishing diets of 17% protein and 14% protein respectively or growing and finishing diets of 14% protein and 11% protein respectively was studied. It was shown that the 17%-14% growing-finishing treatment produced the leanest carcasses with a higher percentage of the live weight in the four lean wholesale cuts. The starter diet treatments were corn-soybean oil meal or corn-soybean oil meal-dried skim milk (10%) diets. They were formulated to contain 21% protein when fed to pigs 3-5 weeks old and to contain 18% protein when fed to pigs 5 to 9 weeks old. Pigs fed diets which included dried skim milk during the starting period produced the most desirable carcasses on the high protein levels during the growing-finishing period and the least desirable carcasses on the low protein levels. Those started on corn-soybean oil meal diets were intermediate. These results suggest that those pigs started on corn-soybeal oil meal diets which contained marginal levels of methionine and lysine, made some adjustment to minimal protein nutrition and that their muscle growth during the growing and finishing periods was less affected by the lower protein levels.

Projects C-34 and C-38

Analysis of Records of Beef Cattle Herds in Maryland

In cooperation with Wye Plantation, Queenstown, Maryland, 51 male and 40 female calves were born in the research herd and 54 males and 53 females were born in the Wye Plantation herd. Feed-gain tests were conducted using 38 males and 34 females of the research and 40 males of the Wye Plantation herds. Due to yearly environmental shifts, the weights and gains of both herds were lower than usual. Sixty-three research herd calves completed their trials. The females averaged 513 pounds at 225 days of age, and 747 pounds when 337 days old, using an average of 2.14 pounds of total digestible nutrients per pound average weight while on trial. The research herd males averaged 581 pounds and 972 pounds at 225 and 365 days of age respectively, and used an average of 2.58 pounds of total digestible nutrients per pound, average weight on trial. All research herd calves were individually self-fed the standard ration while on trial. The bull calves of the Wye Plantation herd averaged 595 pounds when 225 days of age and 927 pounds when exactly one year old.

Continuation of analyses of the data involved using year of birth, season of birth, sex, and age of dam as main sources of variance. Various combinations of weaning age, (weaning age)^2, and inbreeding of the dam, calf and sires were used as covariates.

Adjustment factors for years, season, sex, and age of dam were used to adjust data relative to: (1) weight at the start of feeding periods, (2) gain (3) average weight (4) pounds of total digestible nutrients (TDN) consumed, (5) TDN per pound gain, (6) TDN per pound average weight, and (7) weight at the end for each of 5 periods of 28 day duration as well as longer periods of 84, 112, and 140 days.

Additional analyses are being run and the results will be published as soon as possible.

Project C-39

A Study of the Use of Measurements for the Evaluation of Bred Breeding Stock

Two publications were released during the year. One contains the basic statistics, materials and methods used to study two groups of steers. The second concerned the effects of large ranges in slaughter weight on the use of measurements taken on the live animal used to predict the weights of wholesale cuts of steer carcasses. A third manuscript concerning estimation of the weight of the wholesale rib cut is nearing completion.

Basic analyses of all the wholesale cuts—19 analyses per each of 22 different cuts or 418 in all—have been initiated.

Work continued on obtaining measurements of animals of the research herd in cooperation with Wye Plantation, Queenstown, Maryland.

Project C-40

Study of Variations in Value of Criteria Used in Selection Indices for Beef Cattle

One of the pitfalls that we in the beef cattle industry face today in the improvement of beef cattle is losing sight of what we are selling. The cut of meat the consumer selects—the end product—is still most important.

In a recent survey conducted by the USDA and the National Livestock and Meat Board, "beef was named by 97 percent of all homemakers interviewed as the meat most frequently served." In this same survey, homemakers interviewed showed "woeful lack of knowledge about some meat products."

The success of the beef cattle industry in lifting per capita consumption of beef primarily depends upon giving consumers a constant supply of the meat they like. It has to be good or they won't be back for more. Even though there is lack of knowledge about meat per se, consumers do know what they like and are willing to pay for it.

Therefore, a beef cattle improvement program should include selection of desirable carcass characteristics. One of the main criteria of the research program involving University herds is carcass improvement. Carcass data being collected indicate that improvement in carcass quality and cutability is being made. The carcass data on the progeny of our senior Hereford herd sire have indicated that he has been transmitting desirable carcass characteristics to his progeny. Most of this improvement has been in the following criteria: (1) increase in the rib-eye area per hundred weight of hot carcass; (2) decrease in fat thickness over the 12th rib at acceptable slaughter weight; (3) increase in the marbling score and final carcass grade. The first carcass data were obtained on the progeny of his daughters in 1968 and it is most encouraging—average rib-eye area per hundredweight of hot carcass was 2.04 sq. in.; average backfat thickness at the 12th rib was 0.4 inches; average marbling score was small and the carcass grade was of low choice; average USDA yield grade 2, which was 50.6% yield in boneless, closely trimmed, retail cuts from the round, loin, rib, and chuck.

At the present time there are 16 daughters of breeding age in the Hereford herd produced by our senior herd sire. These daughters are being bred to our first BCIA Performance Tested and Approved Hereford bull. This bull, loaned to the University by a Maryland breeder, has a three generation performance pedigree and his dam is the top producer in the herd. Based on his performance and that of his ancestors, this bull should increase the overall performance of our herd.

Project C-41

A Study of Ruminal Digestion and Absorption from the Rumen

In meat animals, live weight gain is commonly used as an indication of response to nutritional or other environmental treatments and as a measurement of the capacity to produce. The use of body weight or change in body weight as a parameter of animal performance is frequently criticized because weight measurements in themselves do not necessarily predict chemical composition or energy density of the tissue gained. Reliable estimates of body composition in live animals would allow more precise measurements of nutrient utilization or of potential carcass merit. The concept of a reasonable consistency in composition of the fat-free body suggests that measurements of any one of several components (fat, water, potassium, nitrogen, or ash) would allow calculation of general body composition. The nature of weight changes could then be accurately assessed. Dilution techniques that will allow measurement of body water appear to be among the more feasible approaches and experiments designed to measure dilution of antipyrine (AP) and N-acetyl, 4-aminoantipyrine (NAAP) in lambs have been conducted.

Available information indicates that reliable estimates of body composition in lambs can be made from "shrunk" body weights if weights and fat contents are limited to 50-55 kg. and 30% respectively, and also if age is known. In one experiment completed on this project, estimations of body water from shrunk body weight more closely agreed with measured composition ($r=.94$) than did estimation with AP and NAAP ($r=.87$). A second experiment was designed primarily to study changes in body composition and how efficiently lambs utilize energy and protein under alternated feeding regimens. One group was allowed *ad libitum* consumption of a corn-soybean meal-alfalfa meal diet containing 12.7% crude protein. Groups on treatments 2 and 3 were fed a similar diet which contained 16.9% crude protein and were allowed *ad libitum* consumption or consumption of TDN for maintenance alternated as follows: 3 days - 3 days and 6 days - 6 days for groups 2 and 3, respectively.

Feed intakes for groups 2 and 3 were 82% and 84% of group 1 and protein intakes were 102 and 106% of group 1 respectively. Rate of gain varied directly with intake and thus, feed per unit gain was not significantly affected. Body compositions of all lambs were estimated with AP and NAAP and from shrunk weights at the beginning and end of the feeding trials. Results indicated that the lambs which were allowed *ad libitum* consumption increased more rapidly in fat content than did the lambs on the restricted intakes. The higher energy density of the group 1 lambs and the resulting higher estimate for net energy required per unit gain were offset by the shorter feeding period. Lower maintenance requirements resulted thus causing no significant differences in efficiency of energy untilization on feed required to reach a constant weight.

Further studies designed to determine the effects of age and rate of gain on body composition and changes in composition are being conducted with the expectation that regression against both age and weight should be more useful than shrunk weight alone in predicting energy density of the animal body.

The effects of alternating restricted feed intakes on quantities and molar proportions of ruminal volatile fatty acids (VFA) have also been studied. The molar proportions of acetate in the rumina were increased significantly and the molar proportions of propionate and total VFA decreased during the restricted periods when compared to *ad libitum* periods. In spite of considerable variation in acetate-propionate ratios in the rumina, there were no significant differences in the total efficiency of energy utilization (energy in tissue gained plus calculated requirements for maintenance).

Project C-42

Procurement and Study of the Gnotobiotic Ruminant

The term "gnotobiosis" which means "known life" is used to describe the condition of animals reared, in veritable isolation from normal populations of micro-organisms or from microbial contamination. Isolating the ruminant from its rumen population affords an opportunity for studying the metabolism of the ruminant separated from environmental influences which normally profoundly affect its nutritional economy.

Lambs obtained by Caesarean section or by hysterectomy have been reared in plastic isolators. The "germfree" state could be more readily obtained and maintained through hysterectomy. Much of the contamination in lambs obtained by Caesarean section appeared to be due to leaks or to imcomplete sterilization during the surgery necessary for the section. There also was some indication that the interior of the uterus was not completely sterile.

Both gnotobiotic and conventional lambs were fed sterilized, semi-purified diets and a sterile milk preparation. In conventional lambs, digestibility of dry matter from the semi-purified diet was lower than that observed with a "normal" alfalfa-corn diet although the apparent digestibility of added cellulose was similar to that of natural cell wall material. It is believed that the lowered digestibility of the sterilized diet was due to browning reactions which occurred during autoclaving. These reactions resulted in the formation of undigestible protein-carbohydrate complexes. Gnotobiotic lambs were generally unable to digest cellulose and total dry matter digestibility of sterilized diets was considerably lower than in conventional lambs. Ruminoreticular growth and development was greatly retarded in the gnotobiotic lamb and papillary development was virtually absent.

The blood glucose pattern during the first eight weeks was similar to that in conventional lambs although the average level was higher in the gnotobiotes. When a lamb that had been reared in the gnotobiotic environment was transferred to the conventional environment, the blood glucose rapidly declined. However, there was some question as to whether this was due to establishment of an active rumen fermentation or possibly due to an infection and subsequent poor health. Volatile fatty acid (VFA) levels in the gnotobiotic rumen were extremely low (about five percent of normal) when compared to those in conventional lambs of similar ages.

Serum cholesterol and total liver cholesterol were higher in gnotobiotic lambs than in conventional lambs. Fat in gnotobiotic lambs resembled dietary lipids and generally reflected the absence of the hydrogenation of unsaturated fatty acids which would be expected in the normal ruminant.

The results of these experiments to date indicate that both diet sterilization and the absence of rumen function might be confounding nutrient requirements or nutrient availability in the gnotobiotic lamb. Improved appetite and growth could be obtained if the diet was composed primarily of natural feedstuffs supplemented with minerals and vitamins not damaged in the sterilization procedure. Higher food consumption and more rapid growth in the gnotobiotic would be especially desirable in projected experiments in which measurements of energy metabolism and heat production are contemplated.

Project C-43

Equine Serum Transaminase as Related to Muscular Work and Protein Nutrition

Equine research has substantially increased within the past ten years. Veterinary journals carry extensive reviews on the medical aspects of horse science. Further investigation indicates that numerous studies have been undertaken in the areas of breeding, physiology, and general horse practices (riding, horsemanship, etc.). But for the most part, the area of horse nutrition has been ignored. Developments in beef, swine, sheep and poultry nutrition have completely overshadowed any specific new knowledge pertaining to horse nutrition.

Present recommendations for nutrient levels in horse rations have been largely derived from data accumulated with other species. The primary function of the equine is muscular work and not meat production or weight gain as in cattle, sheep or swine. Proper criteria for evaluating nutritional effects upon the performance of the horse need to be developed. Many problems concerning speed, endurance, training behaviors and soundness in horses are often associated with diet or nutrition but the nature or actual extreme of such relationships are not well documented.

Methods of determining muscle development have been studied in order to help the trainer decide when individual animals reach their peak of performance, but at present no reliable procedures have been developed.

The present study was undertaken in order to determine if serum enzymes could effectively gauge conditioning of ponies on a routine exercise schedule. The animals in our study were subjected to varying levels of protein in order to determine: (1) if protein levels had any effect on serum enzymes (SGO-T) in the equine; (2) if any particular level had a significant influence on the length of time to reach peak condition when SGO-T was used as a gauge to determine muscular condition; or (3) if protein levels or exercise had any influence on cholesterol levels in the blood.

Six ponies were rotated on low (7.8%), medium (16.7%) or high (23.7%) protein diets while being subjected to three phases of a routine exercise period. Blood samples were collected before and after exercise and analysed for serum glutamic oxaloacetic transaminase (SGOT), serum cholesterol and total serum protein.

SGOT levels were found to be significantly affected by the high dietary protein diet but not by exercise. A more definite response to exercise was observed when the ponies were required to carry added weight equivalent to 15% of their body weight.

Cholesterol levels tended to increase as the protein level decreased. Only when the animals were fed the high protein diet were cholesterol values consistently observed to decrease after exercise. Serum cholesterol showed a definite response to protein level between before and after exercise samplings with a reverse relationship between dietary protein and post exercise cholesterol levels.

Total serum protein levels increased when the dietary level was raised from 7.8% to 16.7%. Serum protein was not affected by a further increase in protein to 23.7% of the concentrate fed.

One animal which was clinically observed to tie-up showed elevated SGOT levels and consistently exhibited total serum protein levels higher than the other ponies.

Project C-44

BOTANY

The Native Plants of Maryland, Their Occurrence, Distribution and Economic Importance

The usual service continues—the identification of weeds, poisonous plants and wildflowers for Maryland residents, staff members of the Experiment Station and Extension Service. Herbarium specimens are frequently used in such identification.

The floristic study of Assateague Island was completed by Mrs. Elizabeth A. Higgins in her thesis presented for the Masters degree. Four hundred forty-one species, native and introduced, were found. A set of specimens will be furnished to the U. S. Park Service.

Accession of specimens into the Herbarium continues—from personal collections, student collections, and research projects. Speciments are being traded. Maryland and Virginia specimens are going to North Carolina at Chapel Hill to be used in preparation of the flora of the Southeastern States. In return we are receiving an equal number of specimens of plants from southern states. Many of these are specimens of species not found in Maryland. Specimens are being loaned temporarily to various workers in this flora project.

Work is continuing on the Manual of the Woody Plants of Maryland.

Project F-12

Meiotic Studies in Zea Mays and Lilium Superbum

Striking departures from normal floral structure of the regal lily were observed in 48 plants derived from seeds with X-ray induced twin embryos. Flowers with increased and decreased numbers of petals, sepals, and reproductive parts occurred. Other variations included notched, ruffled petals and attractive, open rather than tight trumpet form. The regal lily is a vigorous ornamental and useful variants can be increased for basic and applied studies.

The hereditary factors are carried in the chromosomes and, in this species, each parent contributes a set of twelve.

Chromosomal size and structure are well-suited for analysis. It is known that treatment with X-rays can cause chromosomal breakage and rearrangement. During the next flowering cycle, young buds will be collected to determine if formation of extra embryos and development of unusual flowers are related to chromosomal changes resulting from X-ray treatment of the parental pollen.

Project F-18

Effect of Fungicides and Cellular Metabolism and Control of Vegetable Diseases

Studies of the mechanism of action of folpet showed that the imide moiety of the fungicide does not concentrate in cells nor bind to them. Toxicity seems to result from a sulphur containing fragment of the fungicide which binds to the cells. Other studies revealed that chloroneb interferes with nucleic acid synthesis in *Rhizoctonia solani.* The fungus slowly converts chloroneb to a nontoxic phenol derivative.

Project J-91

Treatment of Soil and Underground Parts of Plants for the Control of Plant Diseases

Soybean phytoalexin was induced by inoculation of the soybean with tobacco necrosis virus and by treating the soybeans with 3×10^{-3}M copper chloride. Fungal inhibitors were produced in the soybeans when they were treated with the fungicide Maneb and when irradiated with short wave ultraviolet rays. The inhibitors thus produced have characteristics similar to phytoalexins.

Aspergillus flavus which produces a highly toxic chemical, aflatoxin, as a by product on media did not produce its characteristic green pigmentation when grown on medium containing 10,000 ppm dimethyl sufoxide. Although both the pigmented and non-pigmented conidia were equally viable the non-pigmented conidia were much more sensitive to ultra violet rays.

Selections of alfalfa from old established fields of Williamsburg alfalfa variety indicated a wide range of resistance, 0 to 75 percent, to Sclerotinia root and crown rot. A polycross line of Narragansett alfalfa produced selections with a wide range of resistance, 10-80 percent, to root and crown rot. Selections of both the above alfalfas show resistance to alfalfa weevil and anthracnose as well as to root and crown rot.

The use of soil treatment chemicals for the control of root rots and nematodes on beans, tomatoes, sweet potatoes, watermelon and cantaloupes indicated that soil treatment is better than seed treatment on bean for the control of the fungus *Rhizoctonia* sp. When soil was treated with a nematocide to control nematodes of tomatoes, there was also a significant early control of Fusarium wilt. Soil treated with chemicals having systemic characteristics for the control of nematodes on tomatoes showed a reduction in the disease. The use of plastic mulch on watermelon produced an increase of yield in the presence of Fusarium.

Project J-93

Development of Improved Strains of Maryland Tobacco Resistant to Diseases

A new variety of Maryland type 32 has been released to tobacco growers to plant in 1969 The variety has characteristics similar to Maryland Catterton, a variety grown by most tobacco farmers. The variety will be known as Maryland 10 with homozygous resistance to TMV. The variety was a cooperative venture over the past 10 years between the University of Maryland Agronomy Department and U. S. Department of Agriculture. Work is continuing on the development of TMV resistant black shank resistant varieties Md 59 and Md 609. The present status indicates that a number of selections of Md 59 and Md 609 have a high degree of resistance to TMV and have retained their resistance to black shank.

Project J-95

Physiology and Biochemistry of Nematodes and Nematode-Host Relationships

In contrast to fatty acids, organic acids occur in very small amounts in nematodes. As a percent of dry weight total, organic acids made up 1.2 percent of the vinegar eelworm, *Turbatrix aceti*, and only 0.8 percent of the fungus feeder, *Ditylenchus triformis*. Of the seven organic acids found in these nematodes, fumaric acid was the major one accounting for 70 percent of the total acids in *T. aceti* and 55 percent in *D. triformis*. Studies with radioactive tracers suggested that both nematode species were able to synthesize the organic acids they contained.

Project J-97

Plant Viruses

Strains of Cymbidium mosaic virus have been isolated from Cattleya orchids. A strain of tobacco mosaic has also been isolated from Cymbidium orchids. The two viruses exhibit symptoms of flower necrosis in the orchids. The symptoms exhibited by the orchids have been reported to be the result of the last differentiating cell of the xylem multiple virus infection. Both viruses, Cymbidium mosaic and tobacco mosaic, have been isolated during the yast year from various genera and species of orchids. In a study on other viruses, it was shown that Southern bean mosaic was translocated through the xylem of certain bean varieties and to exit from and cause a necrotic disease of the bean.

In other virus studies, infection RNA has been isolated and characterized from southern bean mosaic virus. The infectivity of the RNA is rapidly destroyed by ribonuclease at pH 7.0 but not at pH 9.3. The chemical ethylenediamine tetraacetic acid rapidly destroys infectivity of southern bean mosaic when the virus is suspended in distilled water. It was also found that magnesium ions protect the virus from the effects of ethylenediamine tetraacetic acid. Apparently magnesium is necessary to maintain impermeability of the virus particles to ribonuclease.

Project J-98

Nature and Control of Diseases of Ornamentals and Turfgrasses in Maryland

Fusarium roseum which causes Fusarium blight of turfgrasses is a weak pathogen which occurs primarily as a saprophyte on crop debris. It is pathogenic only if vigor of the host has been reduced by inadequate water supply. The severity of Fusarium blight was greatly reduced by frequent but light watering of turf at a time when the fungus was most active. Necrotic lesions developed only on detached leaves that were injured by heating in water at 50°C for 5, 10, or 15 minutes prior to inoculation. Seedling stand reduction and leaf infection occurred only when nutrients were included in the inoculum to increase pathogenicity of the fungus.

Conidia produced by the rust mycoparasite *Darlaca filum* were 100 percent viable after 5 months dry storage at 5°C or under conditions of daily outside temperature fluctuations. When spore masses were diluted and incubated in distilled water for 48, 96, and 144 hours ,the percentage germination on water agar was 80, 65 and 24 percent respectively. Germination was not affected by periods of continuous light or dark or alternate light-dark. Growth and reproduction were stimulated where ground up bean rust spores (*Uromyces phaseoli* var. *typica*) were added to the medium.

A *Coniothyrium* sp. isolated from a canker on an ornamental Bradford pear, *Pyrus calleryana* (Bradford) produced similar cankers when inoculated into healthy plants. The fungus was viable in the cankers one year after inoculation.

Project J-99

Forest Tree Seedlings and Soil Fungi Relationships

Roots of Virginia pine seedlings 10 to 12 days old, rot within 120-140 hours after inoculation with *Pythium debaryanum, Phytophthora cinnamomi* or *Rhizoctonia solani.* If the roots are first inoculated with either *Aspergillus niger* or *Penicillium* sp., both common soil saprophytes, before being inoculated with the pathogens, root rot is delayed approximately 40 hours. This delay is observed even when the saprophytic fungus is killed prior to inoculation with the pathogen, indicating that competition is not solely responsible for the delay.

Culture filtrates of the saprophytic fungi inhibit growth of the pathogenic fungi in culture. These culture filtrates contain citric, gallic, gluconic and oxalic acids—all of which are very inhibitory to the pathogenic fungi.

Microscope sections of roots infected with any of the pathogens show that the cortex is first colonized, and the fungus then moves between the endodermal cells into the stele. Saprophytic fungi also colonize the cortex but do not penetrate the endodermis and so do not cause damping off. These saprophytic fungi apparently provide a mechanical or chemical barrier which retards the advancement of the pathogenic fungi or effectively but temporarily compete with the pathogens for nutrients.

Project J-101

Biophysical and Biochemical Factors in Plant Nutrition

Nutrient-nitrogen levels and the presence or absence of nodules affect the yields of Dare soybean plants in hydroponics in the greenhouse.

In the absence of nodules (left-hand column) the nutrient-nitrogen supply had a profound effect on yield. In the right-hand column, the low-nitrogen plants had an abundance of nodules, whereas the high-nitrogen plants did not form nodules. However, even without nodules, the plants receiving the high nutrient-nitrogen supply yielded about twice as much as those receiving a low nutrient-nitrogen supply.

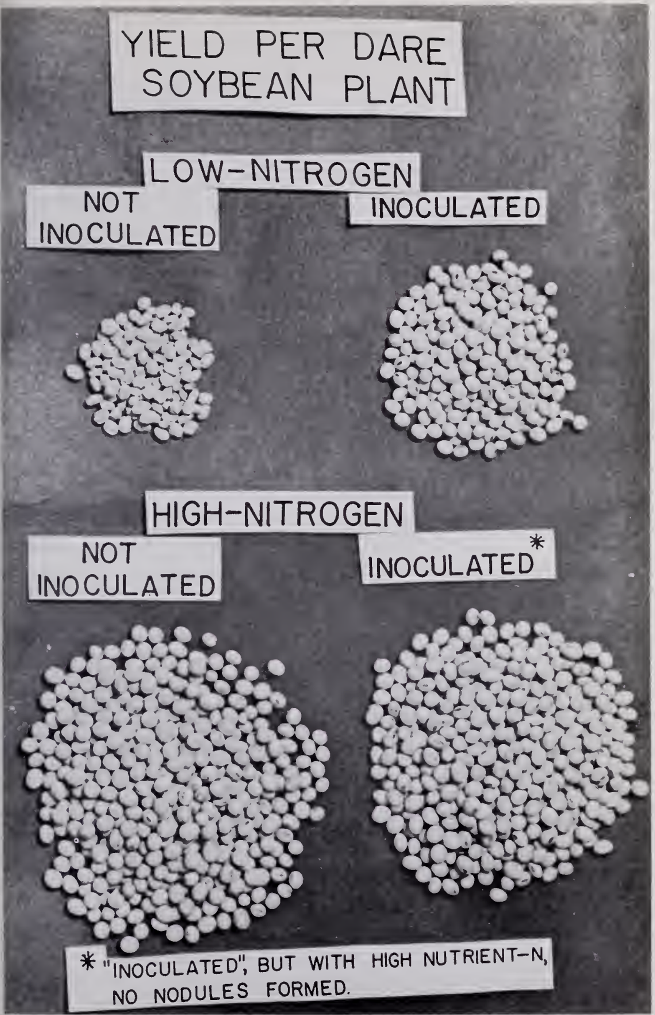
Project K-8-C

Regulation of Protein and Nucleic Acid Biosynthetic Proceses in Plant Tissue

All living cells, the cells of higher plants included, synthesize proteins on specific intracellular organelles. The organelles are called ribosomes. In order for a cell to synthesize protein, amino acids must be supplied as precusors, energy must be supplied as ATP, and information for sequencing the amino acids must be supplied as messenger RNA. The level of protein synthesized by plant cells is strictly correlated with the level of functional ribosomes within the plant cells. Upon illumination of dark grown corn seedlings, the amount of protein synthesized by the plants increases.

We have asked which of the classes of components enumerated above is increased to give rise to more protein synthesis upon illumination of corn seedlings. We have carefully isolated the ribosomal components of corn cells so that they retain their ability to synthesize protein in a test tube. We are trying to experimentally demonstrate that the level of messenger RNA is increased upon illumination and that this, in the presence of ribosomal subunits, results in the formation of functional ribosomes. The increase in functional ribosomes or polysomes should account for part or all of the increase in protein synthesis that we observe in whole plants after they see the light.

Project K-9


YIELD PER DARE SOYBEAN PLANT
LOW-NITROGEN
NOT INOCULATED
INOCULATED
HIGH-NITROGEN
NOT INOCULATED
INOCULATED*
* "INOCULATED", BUT WITH HIGH NUTRIENT-N, NO NODULES FORMED.

Nutrient and Environmental Factors Which Affect the Formation of Lipids in Plants

Culture temperature has been found to drastically affect the fatty acid composition of *Chlorella*. When culture temperature was varied from 38°C to 14°C, the percentage of unsaturated fatty acids was greatest at 14°C and lowest at 38°C. Linolenic acid was present in the largest amounts at 14°C. These results indicate that oil from plants grown in one area may have a higher or lower quality than from plants grown in another area due to differences in average temperature of the environment.

Project K-10

Salinity and Light Interactions in Chlorella

The addition of NaCl to inorganic-culture medium reduced the growth rate of *Chlorella* cells cultured in the medium. Salt-free cultures had a growth rate of 9.6 doublings per day under optimum conditions of light, CO_2 concentration, temperature and medium. Cultures under the same conditions plus 0.2M NaCl grew only two-thirds as fast. At 0.4M NaCl concentrations the growth rate was reduced to near zero. At 0.6, 0.8 and 1.0M NaCl there was no growth. A comparison of these concentrations of NaCl with those in the oceans shows that this organism could not survive at salinities found in sea water. The average salinity of sea water is 35 parts per thousand. Of this 35 about 30 is due to NaCl which is equivalent to 0.5 M NaCl.

In addition to stopping growth, the higher concentrations of NaCl bleached the cells. At 1.0 M NaCl there was a measurable and progressive loss of the green color in cultures left in the dark or light. The bleaching was progressive with time. Dark cultures were yellow after one day and cultures kept in the light were white. Spectrophotometric and fluorescent measurements showed that chlorophyll and carotenoids were being destroyed in cultures containing salt. Time course measurements showed that NaCl and light produced a more rapid and extensive destruction than NaCl and dark. The cultures containing NaCl and exposed to light showed that the red absorption maximum of chlorophyll was shifted toward the blue end of the spectrum. Under certain conditions NaCl and light inactivated the autotrophic recovery of the organism after transfer to NaCl-free medium, whereas NaCl and dark incubation did not.

Project K-11

DAIRY SCIENCE

Chemical Changes in Milk Fat as Related to the Flavor of Milk

Supplementation of the dairy ration with alpha-tocopheryl acetate or with forages rich in natural tocopherols is an effective means of controlling oxidized flavor in milk. Such forages are not always available and chemical supplementation may be too expensive for continuous or prolonged use. The dairy cow is rather wasteful with Vitamin E and less than two percent of that fed finds its way into milk. Experiments were conducted to evaluate the effect of adding the vitamin directly to milk.

The d-alpha-tocopherol in hexane, ethanol and various emulsifiers were added to milk known to be susceptible to copper-induced oxidized flavor. The nonemulsified forms were ineffective. However, the emulsified tocopherol was effective at very low concentrations—the same range found to be effective when the ration was supplemented with the vitamin. Control of oxidized flavor by direct addition of emulsified tocopherol to milk required less than 1/100 of the amount of Vitamin E required by supplementing the ration. The most effective control would result by adding the vitamin preparation at the farm level.

Project G-34

The Analysis of Dairy Products

A method for the detecting of milk fat adulteration with vegetable fat through isolation of the unesterified sterols of the extracted lipid was developed. A column of digitionin impregnated on Celite 545 and the separation and identification of these sterols using gas-liguid chromatography was used. Adulteration with vegetable fats is revealed by the presence of sterols other than cholesterol. At the present time, the method is being refereed by AOAC to establish the method as an official method.

At the request of regulatory agencies (federal, state, etc.), instructional courses have been held during the past year in which the method was discussed, the technique was demonstrated and the results were evaluated. As a result of this activity, the method was used in detecting adulterated dairy products. This resulted in successful prosecution by an eastern state regulatory agency.

Research activities during the past year have been directed to refining the method. Primary considerations were given to using more rapid and simplified techniques for the isolating the lipid fraction from the dairy products. Indications are that the Babcock Method for fat separation can effectively replace the ether extraction technique used in the orginal method.

Project G-35

Studies on the Mode of Digestion, Absorption and Utilization of Feeds by Ruminants and Their Associated Bacteria

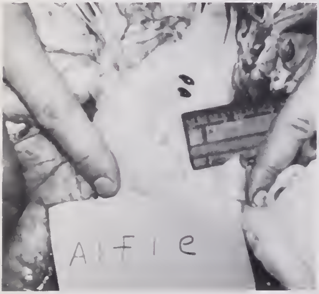
The occurrence of cardio-vascular abnormalities in calves with an esophageal-abomasal anastomosis (forestomach bypass), but not in control calves, brought about a re-direction of research effort on this phase of the project.

Five calves were prepared with the esophageal-abomasal anastomosis. They were fed a milk-replacer containing 10 percent added animal fat, as their sole diet, in an attempt to produce the cardio-vascular abnormalities observed in earlier work. Calves of similar age that did not undergo the operation but that were treated similary to the bypass animals, served as controls.

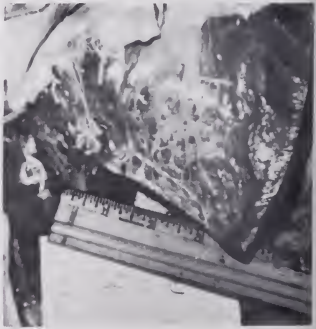
Blood samples were taken from all calves at periodic, specified intervals to determine the effect of age upon glucose, phospholipid, total lipid, and cholesterol levels. Sampling was done in such a manner that the levels of these chemical components could be studied relative to time after feeding as well as to time of day. Statistical analyses have not been done on the data from the chemical tests but there appears to be little or no relation between these and cardio-vascular lesion formation.

Determination of calcium and phosphorus levels in the blood of the calves indicates that these two minerals were present in "normal" amounts in both bypass and control animals. Magnesium levels in the blood were "normal" for both groups of calves but decreased with age in the bypass calves exhibiting cardio-vascular lesions in the left side of the heart. This is the only component analyzed that has shown any relation to the cardio-vascular lesion formation.

Necropsies were performed on the experimental and control calves. Originally pronounced cardio-vascular lesions were found only in calves with a forestomach bypass but in this experiment were observed in both bypass and control animals. These lesions varied from discrete, irregulary shaped, hard



Pulmonary artery of a calf showing lesions including irregularly shaped heart plaques and discolored areas.



Left ventricle of a calf from the aforestomach study showing typical lesions.

plaques 1-2 mm. in diameter, to ill-defined, thickened, discolored areas in the left side of the heart and in the pulmonary artery.

Tissue from various organs of the body was collected and will be prepared for microscopic examination. Chemical tests will be conducted where possible on tissues of the body organs which appear abnormal to try to determine the variation from normal tissues.

Project G-39

Processing Factors Affecting Quality of Ice Cream

Further studies on the use of corn syrup solids as a source of sweetener in ice cream and frozen dairy foods indicate effective usage levels.

Desirable body building effects and handling qualities were observed when as much as 60 percent of the sucrose sweetener was replaced with low D.E. corn syrup solids.

Fructose, hydrolized cereal solids, microcrystalline cellulose, sodium caseinate, whole egg solids, vegetable protein, and low D.E. corn syrup solids have been used successfully in the formulation of dietary frozen dairy foods.

Project G-42

Nutritive Evaluation of Forages

Intake and digestibility values were obtained with dairy steers on four corn silages. Pioneer 1097 and Dekalb XL-45 were each harvested and ensiled with and without the ears removed. The two varieties represent varieties with a low percentage of ear and a high percentage of ear respectively. Intake of dry matter was the same for both varieties. However, the earless silages were consumed at a lower rate which is probably partially due to the high moisture content of the earless silages. While the Dekalb XL-45 had a higher digestible dry matter content than the Pioneer 1097, the difference was small. The fibrous fractions of the earless silages had higher digestion coefficients than the silages with ears. Soybean meal was fed to half of the steers throughout the trials and had no significant effect on intake or digestibility.

Project G-47

Flavor Quality of Concentrated Milk Products as a Factor in Milk Utilization and Marketing

Recent reports from workers on ketosis in milking cows have indicated that addition of the essential amino acid methionine, or some of its analogues, to the diet is an effective treatment for the disease. Some *in vitro* experiments with ruminal digesta from these cows indicated that methionine addition caused a dramatic increase in the microbial lipid in the digesta and that this may be one of the pathways by which the amino acid is effective in treating the disease. If methionine would have a similar effect on the digesta of normal cows, it would raise the exciting possibility of increasing milk fat production via the increased intake of microbial lipid components.

Work at the Maryland station during the past year to test this possibility has given entirely negative results. *In vitro* experiments on the addition of methionine and its hydroxy-analogue to digesta from non-ketotic cows on both high-hay and high-grain rations have indicated that there is absolutely no change in the total lipid content or character of the microbial lipid in the methionyl-digesta. These results do not support the suggestion that methionine supplementation of cow rations will increase milk fat production.

It is possible that rumen lipid metabolism may be abnormal in ketotic cows. A promising area of research on this important metabolic disease would be to determine if the abnormality is the cause or the result of ketosis.

Project G-48

Endocrine Factors Affecting Reproduction in Cattle

Cooperative studies have been initiated with A.H.R.D., USDA, Beltsville, Maryland to examine luteolytic and luteotropic uterine effects in sheep. Preliminary data indicate that sheep embryos may be able to prevent the luteolytic influence of an intraüterine device (IUD) in the ewe. Further study will assist in understanding these processes involved in early pregnancy maintenance.

Project G-50

Endocrine Factors Affecting Reproduction in Cattle

Our studies of the new reproductive hormone which we demonstrated to be present in cattle uteri have continued. Proof of the specific nature of this hormone has been done to the extent that it does not appear to influence adrenal activity. The hamster appears to be an excellent test animal for detecting activity in cattle tissue preparations. Efforts to purify the uterine luteolytic hormone are progressing, as are our efforts to differentiate between the active material which we have found in cattle small intestine. Further studies of uteri from pregnant cows are being conducted to determine the presence or absence of this hormone in very early pregnancy.

Project G-50

Factors Affecting Utilization of Nutrients in Forages

Previous studies had shown that a ration with corn silage as the only forage with a high protein concentrate mix of corn, barley, soybean meal, salt, and dicalcium phosphate was goitrogenic. Fourteen cows which had been receiving this ration for the previous lactation were divided into two groups; half received supplemental iodine and the others served as controls. The supplemental iodine reduced the severity of goiter of calves born to the treatment group. In addition, the cows receiving supplemental iodine produced more milk with a higher fat test, ate more forage, and mobilized more body weight (lost more weight) during the early stage of lactation. The studies clearly demonstrated the goitrogenic nature of the ration and indicate the need for suplemental iodine with the ration used.

Project G-52

A Study of the Development Improvement, or Standardization of Manufacturing Processes for the Production of Various Cheeses and the Effect of Specific Factors on the Flavor, Body and Texture of These Cheeses

Investigations of anaerobic and aerobic fermentations of acid and sweet cheese wheys in the production of whey wine and whey vinegar were continued. Reconstituted spray dried acid and sweet wheys were adjusted to a pH 4.5 inoculated with Saccharomyces fragilis yeast an anaerobically fermented at 35°C. Whey vinegar production was a continuation of the whey wine operation. Whey wine was inoculated with Acetobacter aceti and aerobically fermented at 24°C.

Whey wine of excellent quality was developed. When lactose was the fermentable sugar, a dry wine with an alcohol content of six percent was obtained. Higher levels of alcohol were achieved when the whey was supplemented with sucrose. Depending on the supplementation level of sucrose, dry and sweet wines with alcohol levels of 12 percent were produced. Preliminary studies in the use of whey wine as the base for the production of artificially flavored wines look promising.

Single strength vinegar (4 percent acetic acid) was produced after a 10 day fermentation of whey wine. The product not only possessed the acid character of cider vinegar but also developed condiment flavor and aroma properties normally associated with a seasoned liquid tossed salad dressing. The whey vinegar has excellent commercial potential.

Project G-53

Analysis of Production and Feed Data from Dairy Records

Since the number of herd replacements raised largely determines the extent of genetic progress that can be realized by culling, Maryland DHIA data for 1966 and 1967 were analyzed to relate turn-over rate, calving rate, and herd production level. For these years, the average turn-over rate was greater than the number of replacements raised, leaving little or no opportunity for culling. Also, there appeared to be a positive relationship between calving rate and production level, and between calving rate and turn-over rate.

Statistical analyses of Maryland herd summary records from 1960 through 1967 were also conducted to relate such variables as body weight, herd size, days-in-milk, feeding practices and milk and grain prices to production and income. Multiple regression analyses indicated that about 45 percent of the variation in level of milk production can be accounted for by pounds of concentrates fed, and percent days-in-milk. Average body weight with amount of forage fed, cost of concentrates, milk price, and herd size had little influence on differences in production levels. Similar analyses indicated that milk yield and milk price account for 65-80 percent of the variation in income above feed cost with pounds of concentrates fed, cost of concentrates and amount of forage fed accounting for another 10-20 percent of the variation. Herd size, body weight, and percent days-in-milk were of almost no value in predicting income above feed cost. In no case was more than 90 percent of the variation in income above feed cost accounted for. Increased grain feeding and production per cow from 1960 to 1967 was also evident in these data with concentrate feeding increasing from 3340 pounds per cow in 1960 to 4860 pounds in 1967. Milk production increased from 10,750 pounds per cow in 1960 to 12,167 pounds in 1967.

Project G-54

Factors Influencing the Absorption, Transport, Retention, and Excretion of Pesticide Chemicals in Dairy Animals

Over a two year period, 13 separate trials were conducted to study factors that influence the rate of absorption and excretion of heptachlor epoxide by dairy cows. Absorption was studied during non-lactation as well as lactation. In all, 54 Holstein cows and two newborn calves were used. Some of the cows were used in more than one trial. Heptachlor epoxide was determined by electron capture gas chromatography in milk, feces, urine, body tissue and feed.

Results of this study clearly indicate that the excretion of heptachlor epoxide from body tissue of dairy cows is directly related to the synthesis of milk fat and to the relative concentration of the residue in body tissue.

During periods of no residue intake, the relative concentration (ppm) of heptachlor epoxide in milk fat is essentially the same as the concentration in extracted body fat. This provides a convenient means of estimating total body load of the insecticide. This is probably a reflection of the relation between the long chain fatty acids in milk fat and body fat.

Two trials clearly demonstrated that heptachlor epoxide consumed and absorbed during non-lactating periods is largely retained in body tissue until milk secretion resumes. Placental transfer of the insecicide was also demonstrated in this study.

The accelerated turnover of body tissue induced by thyroprotein supplementation or by under feeding does not significantly increase the excretion rate of heptachlor epoxide from body tissue unless the rate of milk fat synthesis is also increased. Neither approach appears suitable for practical application. Results of this study indicate that optimum conditions for depletion of body residue are those conductive to maximum milk and fat production.

Some of the results suggest that absorption of fat soluble substances influences the rate of excretion of preabsorbed heptachlor epoxide but the practical value of substituting one abnormal substance for another is questionable.

Experiments involving supplementation intended to reduce the absorption of heptachlor epoxide from alfalfa hay produced had no or only a slight positive effect. The irregular intake of residue-containing feed might be of some practical value.

Although a procedure for more rapidly eliminating heptachlor epoxide absorbed by dairy cows was not forthcoming from this study, the information gained should be useful in preventing or controlling future problems involving residues in milk. Some of this information has already been of value to regulatory officials.

Project G-55

Summer Annual Forages for Lactating Dairy Cows

Previous studies of the composition of pearl millet forage had shown a relationship of the organic acids, oxalic and succinic with the milk fat depression of cows consuming the forage. Oxalic acid, potassium oxalate, and succinic acid were fed to cows receiving a ration of hay and grain. Milk fat tests indicated that the addition of the organic acids did not change the milk fat tests. If these acids are related to milk fat depression, the relationship is evidently indirect rather than the factor which produces the effect.

Project BG-2

ENTOMOLOGY

Chemical Control of Insects Affecting Sweet Corn

Six compounds were evaluated for control of ear infesting insects in 1967-68. From these tests, it is apparent that at least two new compounds, Gardona (Shell) and a numbered insecticide, Union Carbide 30045. are quite effective for control of corn earworm and dusky sap beetle. In another experiment, some interesting observations were made regarding the control of European corn borer. It attacks virtually every part of the corn plant, but the most costly injury is to the ears. An experiment was conducted in order to evaluate two chemicals. Each chemical was applied at three different times—when corn was about knee high, when it was in a pre-tassel stage and when it was in silk. Sevin and diazinon were the two chemicals used. There were no great differences between the two chemicals but the time of application was important. Corn sprayed in silk had far fewer corn borer larvae in the ears than did corn sprayed in the earlier applications.

Four new experimental varieties reported to be resistant to corn earworm attack were also evaluated for resistance. All four proved to be resistant. This experiment also indicated that

An ear of corn resistant to corn earworm showing long husk extension compared with a susceptible ear showing earworm injury.

Ears of corn showing two characteristics of earworm resistance. Upper ear has long husk extension, lower exhibits silk balling.

such factors as silk balling and age of silk when infestation occurs influences the amount of injury inflicted to corn ears. It is hoped that through a study of resistant lines of corn and by learning the nature of resistance, this factor can be integrated with chemical control to make the expenditure for chemical control more profitable.

Project H-29-n

Chemical Control of Orchard Insects

Evaluation of concentrate spray equipment for control of orchard pests was carried on in two orchards in the vicinity of Hancock. The first was a commercial orchard of Red and Golden Delicious apple trees. This orchard was used to compare a full-strength program with a three-fourths strength program. Records from the 3X, 10X and 33X plots at harvest indicated that the reduced rate was as effective as the full-strength program. Fruits from plots receiving the full-strength program had 98 to 99 percent clean fruit, while fruit from plots receiving the three-fourths strength program had 92 to 99 percent clean fruit. Unsprayed check trees had only 10 percent clean fruit.

The second was an abandoned orchard of Rome Beauty and York Imperial apple trees. This orchard was sprayed with 3X, 10X, 33X and 66X concentrates, using 105, 29, 9 and 4½ gallons of spray per acre respectively. The Rome Beauty fruits at harvest on the sprayed plots ranged from 90 to 100 percent clean, whereas no fruit was free from pest damage on the unsprayed check. The York Imperial fruits were

95 to 97 percent clean at harvest, while those from the unsprayed check trees had only 7 percent of the fruit free of damage.

As a result of this research, Maryland fruit growers, as well as growers from adjoining states, are now going to higher concentrates than the 3X used over the past 15 years.

Project H-48

External Factors Affecting Insecticide Degradation

Efforts to evaluate the effects of external factors on the rate of insecticide degradation have continued. Residues of dimethoate in spinach were not dissipated as rapidly when the insecticide was applied during the winter as during the summer. Nevertheless, residues were less than the tolerance of 2 parts per million very soon after treatment. Small variations in the temperatures during different periods throughout the winter did not seem to significantly affect the degradation rate of dimethoate in spinach. However, when compared with the summer applications, where residues were not detectable within 10 days after application, degradation was markedly slower.

Since earlier work had indicated that soil type had a greater influence on the rate of decomposition of insecticides in soils than temperature, experiments were conducted to evaluate the effect of 2 different soil types found in Maryland on the degradation of disulfoton. Sampling has been completed and analyses are in progress.

Monitoring of commercial samples of various commodities has revealed that there are no significant residues of the persistent chlorinated hydrocarbons contaminating processed food from the Eastern Shore of Maryland. Monitoring of such samples is continuing.

Project H-67

Alfalfa Insects: Their Biology and Control

Investigations on the parasites and predators of the alfalfa weevil are continuing. The parasitic wasps of the the family Braconidae, genus *Microctonus* are being studied in considerable detail. The release of laboratory reared populations is anticipated in 1969.

Emphasis has also been placed on the evaluation of insecticides. In the spring of 1968 four registered and three unregistered spray materials were carefully tested. Applications were made on May 2 when the alfalfa was 19 to 20 inches tall and heavily damaged. It was found that Methoxychlor alone would not hold larval populations below economic levels for an extended period of time. Damage by weevils was heavy 19 days after treatment. Good results were obtained with the new materials, Furadan (R) and

Possible candidates for biological control agents, two parasites attack an alfalfa weevil.

Supracide (R). The standard malathion-methoxychlor mixture or methyl parathion gave satisfactory control for seven days.

In another test Furadan (R) and Baygon (R) gave superior control. Three other experimental materials performed satisfactorily. Valuable information about phytotoxicity was obtained.

Three granular materials were also evaluated. One of the materials was found to cause heavy burning of leaves (systemic phytotoxicity). Furadan (R) was found to be superior to Dursban (R).

Project H-71-d

Physiology of Insect Reproduction

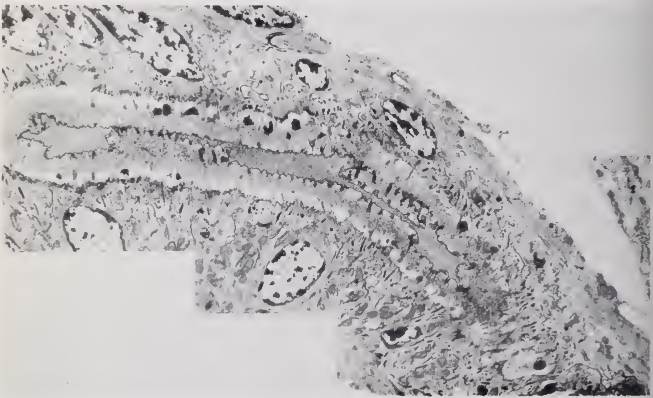
One of the major puzzles concerning the physiology of reproduction of mosquitoes is that female mosquitoes which have mated for only a single time are generally highly unreceptive to a second mating. Those few females which do mate a second time are said to eject the sperm rapidly from their reproductive systems. We have observed that while more than one-half of the virgin males do not show any detectable reactions to recently mated females, the remainder of the males show definite reactions. Even so, only 4% of the males attempted to copulate with inseminated females. We discovered that it was possible to make these inseminated females either almost totally unattractive or almost totally receptive to males. The inseminated females were made unattractive by immersing them in hot water prior to presentation to the males. When 10 females were immersed in water at 50°C for 25 minutes, none of them were attractive to males. The inseminated females were made highly attractive to males when they had been rendered completely motionless by placing them in the freezing compartment of a refrigerator for 45 seconds. As soon as similar females were allowed to recover at room temperature, they were again not attractive to the males.

Project H-72

The Mosquito Fauna in Selected Swamps, Marshes and Impoundments

A long range study of the mosquito, *Culiseta melanura,* was concluded in 1968. This mosquito is the principal vector of eastern equine encephalitis from bird to bird. Other species of mosquitoes are largely responsible for the transmission of the disease to man and horses. It was found that *C. melanura* is present in all 9 counties of the Maryland Eastern Shore but largest populations are on the lower Eastern Shore, i.e. in swamps of Dorchester, Wicomico and Worcester Counties. This species was present at 101 of the 121 locations where collecting was done with CDC miniature light traps during 1965 through 1967.

Larval habitats are generally small shaded depressions in the swamp or forest floor which contain cool acid water most of the year. Twenty-six breeding sites are reported from Mary-



Electron micrograph showing a portion of the spermathecal duct of a mosquito.

land. Larvae overwinter in all stages but are generally difficult to find during the winter months. The collection of a few 1st instar larvae during January, February and April proves that they are capable of surviving the winter. There are reports in the literature of survival of 2nd, 3rd and 4th instar larvae through the winter but no reports of 1st instar larvae overwintering. Larval development in swamp habitats is very slow, extending over a period of 2 to 3½ months. This indicates that there are only two summer generations and one overwintering generation in Maryland. *C. melanura* larvae were frequently the only mosquito species present in the breeding sites. At times they were associated with larvae of the following species: *Aedes canadensis, Culex territans, Aedes thibaulti, Culex restuans* and/or *Culex pipiens.*

Adult emergence is known to begin by April 21 which is the earliest date that adults have been collected by any method in Maryland. Emergence continues throughout the summer until October 25. Male emergence peaks were generally somewhat ahead of female emergence peaks. There were 2 early seasonal peaks and one late seasonal peak of adult emergence. Peaks of male emergence were late May, early July and early October. The peaks of female emergence were mid-June, early July and early October. Migration or dispersal of *C. melanura* adults occurred soon after emergence as indicated by the collection of specimens in resting boxes on farms bordering the Pocomoke Cypress Swamp, Maryland.

Blood-feeding begins in late April. Oviposition begins in late May and continues into November. Females were collected as late as December 16. The specimens which were collected late in the fall were capable of surviving 20 hours exposure to temperatures as low as 22° F., but they did not appear capable of surviving the winter in Maryland. They showed signs of egg development and, unlike overwintering *Culex* species, were without fat reserves.

Populations of *C. melanura* as determined with CDC miniature light traps in Pocomoke Cypress Swamp fluctuated greatly during 1965 and 1966. Population peaks occurred at irregular intervals. Largest peaks were observed before mid-August. There were 2 peaks in the male population and 4 peaks in the female population during each year. Resting box collections on farms as compared to collections in swamps and wooded areas showed that the resting box yielded the largest number of blood-fed *C. melanura* on farms. The resting box also provided a means of collecting specimens late in the fall after cold weather prevented night collections and light traps. The CDC miniature light trap was a more efficient collecting device in wooded areas.

The vertical distribution of *C. melanura* adults as determined with CDC miniature light traps in the Pocomoke Cypress Swamp indicated that the population density of both males and females was greatest at 5 feet and diminished as the height increased. Males outnumbered females at 25 feet and the sex ratio approximated 1:1 at 45 feet. The bait traps used in this study were ineffective at catching *C. melanura.* The louvers appeared to repel this species. Only 28 females were collected in bait traps during the entire study. There was evidence that *C. melanura* did not enter and leave the traps as periodic night collecting did not increase the number caught. In the Pocomoke Cypress Swamp where *C. melanura* was the dominant mosquito, numerous observations made to determine the relationship of this species to a human host produced only 1 record of this species being attracted to man. Collections from horses near the swamp were negative.

Precipitin tests on blood-fed *C. melanura* produced 1776 positive reactions indicating feeding on the following hosts: birds 87.6 percent, dog or cat 7.5 percent, raccoon 1.9 percent, swine 1.1 percent, reptile 1.0 percent, bovine 0.3 percent, rat (rodent) 0.3 percent, deer 0.3 percent. Passeriform birds constituted 84.4 percent of the hosts (972 of 1151) during 1966 and 1967. Two new host records were found and include cat and Charadriiformes. For the most part, no spectacular variations in seasonal and geographical feeding activity were detected. One collecting site, the Merrill farm 0.5 mile east of the Pocomoke Cypress Swamp, showed a high percentage of mammalian feeding during 1967. Precipitin tests performed at Salisbury, Maryland and those performed at Berkeley, California on the same blood-fed specimens showed only slight differences.

Diel activity of *C. melanura* females as measured by CDC miniature light traps, was highest during the pre-midnight (2000-2400 hours) and post-midnight (0000-0400 hours) periods at 5 feet, 25 feet, and 45 feet. Activity was greater during early morning (0400-0800 hours) than evening (1600-2000 hours) and there was very little daylight activity. Diel activity of *C. melanura* males was greatest during the pre-midnight period (2000-2400 hours) at an elevation of 25 feet. Activity in swamps as indicated by CDC miniature light traps was greatly increased during rainy nights. Resting box collections on farms near the swamps were largest on calm, humid or foggy mornings. Above average rainfall during 1967 favored dispersal and increased populations of *C. melanura* as moderate numbers were collected in several areas which were previously negative. However, EEE virus activity as indicated by reported equine cases appeared to be very low on the Eastern Shore during 1967.

Factors necessary for an EEE epidemic are present on the lower Eastern Shore of Maryland and include: (1) viremic passeriform birds; (2) large populations of the endemic vector *C. melanura* which has been shown to feed extensively on passeriform birds; (3) large populations of potential epidemic vectors including *A. sollicitans* and *A. vexans.*

Project H-73-a

Biology and Control of Tobacco Insects

The systemic insecticide has now taken its place in the culture of Maryland tobacco. DiSyston in 1967 was recommended on a trial basis. On privately owned land, DiSyston was evaluated in a large field experiment. It was broadcast prior to planting and banded at planting time. Both methods of application resulted in complete control of green peach aphid. Four other compounds were evaluated in small plot experiments. These compounds were applied at various rates and as broadcast, side dress treatments and foliar sprays. Meta Syston R was very effective as a foliar spray. Temik, a compound manufactured by Union Carbide, was completely effective for control of aphid, whether banded or broadcast. It was as effective at 3 pounds per acre as it was at 8 pounds per acre. Furadan, by Niagara, was not as effective for control of aphids but it was the most effective compound for control of the tobacco flea beetle.

Project H-74

Comparative Morphology and Physiology of Insect Blood Cells

Prior to determining how a series of specific insect pathogens affect the blood picture of an insect, one must have detailed quantitative information on the normal insects under a variety of conditions. Hopefully, the insect's blood picture might be as useful in diagnosis of certain types of diseases as is the blood picture of man and some other animals. We have determined the major types and numbers of hemocytes (insect blood cells) in the Fall Armyworm during the last larval stage under normal feeding conditions and under fasting conditions. Studies have also been made on the effects of injecting saline and other substances into the body cavity of the larvae. This information will now be used to study the effects of pathogens on the hemocytes and to determine whether the blood picture can be of diagnostic value.

Project H-76

Utilization of the Polyhedrosis Virus for Commercial Control of the Cabbage Looper

Cabbage looper nuclear polyhedrosis was produced for field testing on cole crops at the University Experimental Farm, Salisbury.

Studies were undertaken in which attempts were made to correlate field and laboratory data. Comparisons were drawn between the naturally-occurring epizootics and prophylactic sprays applied to reduce looper damage to field crops. The results suggested that the absolute number of polyhedra remaining in the field is higher after a naturally-occurring epizootic than if prophylactic sprays are applied to maintain looper density below the economic injury level.

Project H-81

A modified automated packaging machine used for mass rearing insect larvae required for virus production. The viruses produced in the laboratory are tested in the field as possible biological control agents.

Host Preference of Alfalfa Weevil, Hypera postica (Gyll.) in Relation to Plant Produced Attractants and Repellents

Studies on the oviposition response of the alfalfa weevil were intensified in 1967-68. The oviposition rate of mature alfalfa weevils was found to be markedly influenced by extracts of fresh alfalfa and red clover plant material. The expressed juice of alfalfa stimulated oviposition, whereas that of red clover inhibited egg laying. Attempts to isolate the active component(s) of the alfalfa juice with 5 solvents failed. However, the deterrent from red clover was found to be soluble in *n*-hexane and insoluble in diethyl ether or water. The reduction in the rate of oviposition brought about by feeding red clover juice was much more marked than the increase caused by alfalfa juice. Thus it appears that under laboratory conditions, the deterrence to oviposition exerted by red clover is more significant than the stimulation by alfalfa. It may well be that the acceptance of an oviposition host by the alfalfa weevil in the field is more the result of absence (or a reduction in the amount) of deterrents in alfalfa rather than presence of stimulants. However, a detection of such deterrents in red clover could constitute a problem since rarely are alfalfa weevil larvae or adults found feeding on this legume in the field. Under forced conditions in the laboratory, however, weevil adults fed on red clover to the same extent as on alfalfa. Therefore, it follows that no active deterrents to adult feeding are present in red clover.

In the laboratory, continued heavy oviposition in red clover occurred as long as alfalfa plant material was available. However, under such circumstances, little or no feeding was found on the red clover foliage. What is apparent from these facts is that the alfalfa weevil has evolved to the point where it selects alfalfa by virtue of this legume producing volatile attractive materials, feeding stimulants, oviposition stimulants and other compounds (secondary compounds?) which may be peculiar to alfalfa, or at least to the genus *Medicago*. In the random movement associated with the initial stages of food finding, many plants may be sampled by this insect. However, absence of attractants and/or stimulants (of the sort found in alfalfa) coupled with the presence of deterrents (of the sort found in red clover) causes a virtual rejection of all species other than *Medicago sativa* L. If the adult insect is confined to a normally unacceptable plant such as red clover, the effect on the metabolism of the insect is such that feeding and survival of the individual so confined may be normal, but oviposition is inhibited. Where the choice of alfalfa and red clover is available, the weevil must feed on the former to oviposit. If continued feeding takes place in red clover, the result is the ingestion of materials which bring about an overriding of the stimulating effect of alfalfa and subsequent inhibition of oviposition.

Experiments using alfalfa or the expressed juice of alfalfa showed that the leaf is the major site of any chemical oviposition stimulants found in this legume. However, it is clear that both stem and leaf are required for normal levels of oviposition to take place. The function of the oviposition stimulant produced by alfalfa appears to be release of eggs from the ovary. No differences in development of female reproductive organs were found between insects which had been confined from eclosion on either alfalfa or red clover.

Selective removal of tarsi, antennae, or antennal clubs showed that these appendages are not used to detect either stimulatory or inhibitory chemical or tactile cues associated with the oviposition response by this insect. Regardless of the nature of the operation, oviposition generally proceeded at normal levels on alfalfa, and at minimal levels on red clover. However, oviposition ceased entirely with weevils whose mouthparts had been either removed or sealed. This suggests that ingestion of the alfalfa-produced oviposition stimulant must take place in order for egg laying to proceed. The fact that no oviposition took place in red clover under such circumstances could be attributed to the detection of repellent substances by means other than those associated with tarsal or antennal organs.

In several instances it was shown that alfalfa weevils react quite definitely in their egg laying responses to manipulations of their environment. In general it was found that it was the number of adults per container, and not the size of the container itself, which influences the oviposition rate. In jars containing more than 2 evenly-sexed adults, a marked decrease in egg laying was found. In the field, high adult populations in the fall have been shown to be consistently followed by correspondingly high adults/larvae ratios the following spring in both New Jersey and Maryland from 1964 to 1967. It may well be that adult "crowding", resulting in subsequently reduced levels of egg laying, is causing this. However, such an effect on this ratio could possibly be caused by increased larval competition for food followed by high larval mortality under such circumstances. Since frequent changing of plant food resulted in increased levels of oviposition, and since aging of plant material did not affect this response, it would appear that ovipositing females deposit materials on the alfalfa plant which deter other females from laying eggs in the vicinity of egg punctures. Attempted removal of any such deterrent from infested alfalfa by washing with distilled water failed.

Project H-84

Transformations of Insecticides by Plants

Research at the Maryland Agricultural Experiment Station has assisted in the registration of a potentially important insecticide-nematocide for use on tobacco and corn. Mocap, a newly developed organophosphorus compound, has shown great utility in soil applications for various insects and nematodes. Beans and corn have been grown in soil treated with radiolabeled Mocap applied as a 10 percent granular formulation. The only compound isolated from the soil itself throughout the experiment was Mocap. Approximately 35 to 45 days were required for half of the applied Mocap to disappear from the soil. Only a small amount of the administered radioactivity was taken up by the plants from the soil. Of the radioactivity extractable from the plants, only a small portion is organosoluble, and thus potentially toxic. The remainder of the radioactivity consists of either hydrolysis products or is incorporated into plant constituents. The metabolic products of Mocap are the same in both corn and beans, but degradation is more rapid in beans than in corn. Characterization of metabolites is in progress but it does not appear that any metabolites of Mocap formed in plants will present a toxic hazard to man or animals.

Project H-85

The Biology of Biting Midges of the Genus Culicoides in Maryland

The biting midges continue to be a nuisance to men and domestic animals both in coastal swampy areas and wooded inland areas. Their extremely small size makes it difficult to find their breeding places and to control them. A survey of *Culicoides* breeding sites in Maryland yielded 14 species from various parts of the state. With the exception of two species, all were reared from larvae to adults in the Entomology Department laboratory. A colony of one species, *C. guttipennis,* was maintained through five generations on an artificial medium made from distilled water and tree leaves. A successful adult feeding technique using rabbits permitted the feeding of up to 200 adults at a time. Favorable conditions for egg laying were developed and more than 13,000 eggs of *C. guttipennis* were laid. Hatching success varied—in some batches it was as high as 97 percent. Experiments with the rearing of larvae on artificially raised fungal substrates were partially successful.

A new aspect of the biology of the midges of the family Ceratopogonidae began with a cooperative agreement with USDA to make "A Revision of North American *Forcipomyia*." These small midges are not well known in North America but in the tropics they are the chief pollinators of cocoa and rubber trees. Larval and pupal habitats under the bark of dead trees were discovered and several hundred adults of three species were reared in the laboratory. Slides and detailed drawings of all stages were made. Micro-dissections of immature stages were also done. A survey of the specimens of *Forcipomyia* in the U. S. National Museum was conducted with special emphasis on a subgenus *(Neoforcipomyia)* that parasitizes other insects.

During the field work a new genus and species of parasitic wasp of the family Encyrtidae was discovered parasitizing larvae and pupae of *Forcipomyia*. Studies of the life history of this wasp were conducted.

Project H-86

The Control of Bird Depredation

Blackbirds, especially Red-winged Blackbirds and Common Grackles, continue to be a serious problem for Maryland corn growers. They are increasing in numbers in the eastern half of the state and are very destructive to ripening corn in fields near watery marshes.

To study a safe technique in reducing their numbers, a chemosterilant called TEM (Triethylene melamine) was dissolved in water and mixed with cracked corn which was placed on plywood platforms in a Red-winged Blackbird nesting area on Kent Island in the Chesapeake Bay. One hundred and thirty nests were observed in the test and control areas. In the test area 39 percent of the eggs were inviable showing the effects of the chemosterilant.

To study the movements of the blackbirds throughout the year, four decoy traps were erected and over 1400 blackbirds were banded and released. Redwing nestlings were also banded.

To frighten birds from corn fields in August various scare devices were tested. Plastic owls on poles were used in 4 tests, plastic hawks suspended from a balloon were tried in 2 tests, and Starling distress calls were also tried. The last two techniques showed great promise.

One test using bird resistant corn was only moderately successful in reducing damage.

Project H-87

Oxidation of Organophosphorus Insecticides in Mammals

Research leading to the characterization of oxidative metabolites of a number of organophosphorus insecticides produced in mammalian systems has continued. Samples of dimethoate radiolabeled in unique positions have been prepared in order to evaluate the nature of certain metabolites which have been known for some time but whose structures have not been determined. Unknown metabolites of phosphamidon have been investigated by selective chemical degradation of the compounds and analysis of the fragments produced.

In an attempt to extend the results of previously determined interaction between phenobarbital and organophosphorus insecticides, groups of mice were fed standard diets into which were incorporated two levels each of DDT and dieldrin. Both DDT and dieldrin resulted in decreased toxicity of both Bidrin and phosphamidon. The higher level of DDT and both levels of dieldrin resulted in increased toxicity of dimethoate. The high level of dieldrin resulted in the greatly decreased toxicity of malathion. These results indicate that chlorinated hydrocarbon insecticides can cause the same effects on organophosphorus insecticide toxicity to animals as phenobarbital.

Preliminary experiments have been conducted with cell culture preparations and rat liver microsomal systems to investigate the oxidative metabolism of these materials. Preliminary results are promising.

Project H-90

The Influence of Nutritional Variation in the Development of Larvae and Adult Honey Bees

Under hive conditions pollen consumption by newly emerged adult honey bees is negligible during the first 2 hours. Under laboratory conditions continuous pollen consumption in roughly 85 percent of bees begins about 6 hours after emergence, and about 10 hours under hive conditions.

Flight cage studies showed that newly emerged bees could not rear brood when fed mixtures of dandelion pollen and commercial invert sugar alone or when mixtures were fortified with L-tryptophane and L-phenylalnine. Nor could brood rearing be initiated by the addition of B-complex vitamins to a dandelion-sugar mixture. When mixtures of pollen containing 49 percent dandelion and 51 percent unidentified pollen were mixed with invert sugar and fed to newly emerged bees, brood rearing was not possible. However, when the proportion of dandelion pollen was reduced to 10 percent, brood rearing was possible. Unidentified mixed pollen from College Park, Maryland at 7.5 percent and 10.0 percent levels but not at 1.0 percent, 5.0 percent, and 50 percent supported brood rearing. Observations on hypopharyngeal gland development were correlated with brood rearing capability. Amino acid analysis indicated that pure dandelion pollen was deficient in arginine when compared with pollens supporting brood rearing. One conclusion from this study is that actual brood rearing, that is, the production of healthy adults, is the best criterion for evaluating diets of honey bee workers for purposes of developing possible pollen substitutes.

Project H-93

HOME ECONOMICS

Utilization of Amino Acids from Peanut Protein by College Women

To meet the protein needs of an increasing world population and the proportional decreasing availability of animal proteins, plant proteins and protein mixtures will be required in larger and larger amounts.

The purpose of this human nutrition experiment was to determine the utilization of amino acids of peanut flour (defatted) compared to casein-lactalbumin (5:1 ratio) when both were supplemented with pure crystalline essential amino acids to the FAO provisional pattern. Tyrosine and phenylalanine were treated as a total aromatic amino acid requirement, with no less than 50 percent supplied by phenylalanine. The non-essential amino acids in the milk pattern were used to equalize total nitrogen. Previous studies by the Northeast Region of the Agricultural Experiment Stations with both humans and animals have shown that casein-lactalbumin, supplemented to the FAO provisional pattern, was superior to giving crystalline amino acids in the FAO pattern.

Twelve college women, 17 to 20 years of age, volunteered as subjects, and ten completed the experiment. Their weights ranged from 53.0 to 71.4 kg. Each was in good health as determined by a medical examination.

Each subject received 0.4 gm of protein per kg of body weight, or 0.064 gm of nitrogen per kg of body weight. This level had been previously considered by the Agricultural Experiment Stations of Maryland, Rhode Island and Vermont as the lowest nitrogen level that would maintain human subjects in nitrogen equilibrium. Concurrent with this study of the utilization of peanut protein, the Vermont station investigated the utilization of spun soy protein on college men and the Rhode Island station determined the availability of amino acids of fish protein concentrate for college women.

Analysis of urea and ammonia nitrogen.

The feeding pattern consisted of (I) a 7-day preliminary period of natural foods with the protein source primarily beef. During the two 10-day experimental periods (II) and (III) a crossover experimental design was used. At random, in period II, half the subjects were given casein-lactalbumin while the remainder received peanut flour. In period III, the eating pattern was reversed.

The average caloric intake during the intake of beef (2616 kcal), casein-lactalbumin (2747 kcal) and peanut protein (2718 kcal) was not significantly different. The diets were supplemented daily with a multivitamin capsule and the Leverton et al. mineral mix. The initial and final weights of the subjects differed at most by 0.5 kg, which was not significant.

The parameters of the study were nitrogen balance, creatinine, urea nitrogen, ammonia nitrogen, body weight and hemoglobin. Daily 24-hour urine and fecal samples were collected. The nitrogen content of the urine, fecal composite and food composite was determined by the Kjeldahl method. Creatinine levels were determined on the urine each day. In the preliminary period, a 7-day fecal composite was analyzed for nitrogen. During the experimental periods, 5-day fecal composites were used for nitrogen determination.

There were no significant differences in the creatinine and hemoglobin levels of the subjects. The mean nitrogen intake of all subjects was 3.79 gm. At this level of nitrogen intake, all subjects were in positive nitrogen balance regardless of the source of protein. A highly significant ($P<.005$) nitrogen retention resulted when the subjects consumed casein-lactalbumin as compared to peanut protein. These differences in nitrogen retention were reflected in the urinary nitrogen losses which were significantly higher for peanut protein ($P<.005$). There were no significant differences of fecal nitrogen values due to casein-lactalbumin or peanut protein.

The results of this experiment make evident that the content of amino acids alone, of a protein supplemented to the FAO pattern, does not provide an adequate explanation for the marked differences in the nitrogen retention and nutritive value.

Project NE-52, Y-4

Effects of Refrigerator Storage of Fresh Broccoli, Blanching Solution and Packaging on pH, Acids, Chlorophylls, Dehydro and Reduced Ascorbic Acid in Broccoli

Vegetables are often stored for several days before processing, especially at the peak of the season. Fresh vegetables purchased from the retail market have necessarily been stored for a period of time during transportation and holding in the market. Thus it is of interest to study the effects of these storage periods on possible loss of quality and nutritive value.

In this experiment, Primo variety of broccoli was stored for 0, 2 and 4 days at 38°F, blanched in water and by microwaves, packaged conventionally and in boil-in-bag pouches and freezer stored for 1 and 5 months before cooking. Samples were analyzed for vitamin C (ascorbic acid), chlorophylls (color) and acidity.

Storage for 2 or 4 days at 38°F caused an increase of approximately 16 percent in vitamin C content of broccoli. The reason for the unexpected increase cannot be explained at present but the work is being continued with several varieties of broccoli. Acids increased and pH decreased during storage. However, these changes did not affect color (chlorophyll) of the processed and cooked samples.

Microwave blanching had been found previously to retain more vitamin C than water blanching but color (chlorophyll) was not well retained. In the present experiment a pre-soak in phosphate-citrate buffer pH 7 was tried in an attempt to control pH and diminish color loss. The results showed that this procedure was not sufficient since chlorophyll losses were still greater in microwave than water blanched broccoli. Ascorbic acid (vitamin C) was higher in the microwave blanched on the fresh basis. Broccoli packaged in boil-in-bag pouches retained more vitamin C than conventionally packaged but retained slightly less color (chlorophyll).

Broccoli freezer stored for 5 months was lower in vitamin C than that stored for 1 month but there was no difference in loss of color (chlorophyll). Processed broccoli, i.e. broccoli which had been blanched, packaged and freezer stored by all methods studied, retained 72 percent of the vitamin C and 75 percent of the chlorophyll contents of the fresh raw broccoli.

After cooking, the processed broccoli contained only 47 percent of the original vitamin C and 42 percent of the chlorophyll.

From the results of this study, it is evident that storage of fresh broccoli up to 4 days at 38°F was not detrimental to its vitamin C or chlorophyll content. However, after cooking the stored frozen broccoli less than half of the original amounts of vitamin C and chlorophyll remained.

Project Y-5

HORTICULTURE

Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Cut Flower Crops

Culture of Carnations

Carnations grown in Maryland greenhouses are second only to chrysanthemums in wholesale value and are considerably more important than roses. There has been no expansion in carnation production in the northeastern states in recent years due largely to air freight shipments of cut carnations from more distant production areas. Recent experimental work has centered on improving quality, increasing production, reducing cost, and timing the crop for favorable market periods.

Carnation production and quality was shown to be best with fertilization practices providing a high nitrogen, medium phosphorus, and high potassium level such as might be provided by the continual use of a 5-1-4 fertilizer ratio. Soil mixtures for greenhouse carnations must be well-drained in addition to being capable of supplying large amounts of moisture and fertility. Mixtures of soil, peat moss and perlite, limed to a pH 6.5 level were shown to be adapted to carnation production. Good growth was maintained when a 25-5-20 analysis fertilizer was used consistently in the irrigation water at the rate of 8 ounces per 100 gallons. This was accomplished satisfactorily by proportioning the soluble fertilizer into the water supply. It was also demonstrated that the water and fertilizer control could be accomplished automatically by the use of devices for applying water to greenhouse soil (surface sprays or capillary applicators) as well as a device for regulating the soil moisture content designed primarily for potted plants ("Moist Scale").

Attempts over a period of years to improve the production and quality of greenhouse carnations under Maryland conditions by the enrichment of the air with additional carbon dioxide were inconclusive because benefits were not consistent and did not appear commensurate with the cost of materials and equipment used.

Our early trials and commercial practices had indicated that flower production for the Christmas holiday market was best when young plants were planted in June and topped in early July. Recent work has shown benefit from the use of artificial light in timing the production of carnations for Christmas (or any desirable market period) more predictably by concentrating production and reducing the total time to flowering as well as the actual production of more flowers.

Experiments conducted in environmental control rooms indicated that under continuous light, the number of pairs of leaves on a flowering carnation stem was greatly reduced, representing an earlier flower initiation than shoots grown under an 8 hour light period. Furthermore, earliness of flower initiation was promoted by as few as 2 weeks of long days during the fourth through the sixth week following topping of young plants.

Project I-74-b

The Relationship of the Mineral Nutrients and of Nutrient Levels to the Growth and Development of Certain Woody Ornamental Plants Growing in Containers

The container growing of woody ornamental plants offers an efficient and economical method of production for present day markets. Cultural techniques and practices suitable for field production are not necessarily adapted to container growing. Fertilization plays an important role in container production. Plants growing in specially prepared soils and watered frequently need a regularly available or supplied source of nutrient materials. Such fertilizer may be supplied either in a water soluble or in a slowly released dry form.

The use of slow release fertilizers for container growing appears to be a satisfactory method of fertilization. For the Japanese Holly, *Ilex crenata*, the addition of 8 oz. of 18-9-9 Osmocote, a slow release fertilizer, per bushel and for *Pyracantha coccinea* 10 oz. per bushel, supplies sufficient nutrients for satisfactory growth during the first 8 weeks after potting. To maintain this growth it is necessary to follow with a regular application of a soluble fertilizer in the water supply.

Another method of using slow release fertilizers is with container tablets, that is the fertilizer compressed into a tablet form. With Ilex and Pyracantha, one 12 gram 14-4-6 container tablet placed on the soil in an 8 inch pot every 3 weeks, or 2 tablets every 6 weeks, produced growth comparable to a program that supplied fertilizers regularly in the water supply. In the latter method, soluble fertilizers are mixed into the water and this solution then injected into the water supply going to the plants in a dilute form. If such a solution is made sufficiently dilute, it may be applied each time the plants are watered. In this manner the plant is assured of a steady supply of fertilizer at all times.

Project I-79-M

Temperature and Photoperiod of Greenhouse Cut Flower Crops

Greenhouse experiments have shown that incandescent light is much more effective than fluorescent light in promoting flowering of carnation. As little as 3 foot candles of incandescent light could be effective. Lighting from 9:00 PM to 3:00 AM was as beneficial in the promotion of flowering as the use of continuous lighting. While many practical uses for carnation lighting have been proposed, the recommended procedure for the production of Christmas carnations can now be:

1) Plant Aug. 1.
2) Top young plants Aug. 21.
3) Light each night with incandescent lamps from Sept. 5 to Sept. 30.

Project I-79-n

Environmental Factors and Cultural Practices in Relation to the Growth and Fruiting Responses of Fruits

Concentrate Spray-Thinning Limited in Effectiveness

Concentrate application of pesticides with air-blast equipment in Maryland orchards is now commonplace. Questions regarding concentrate application of chemical thinning sprays on apples inevitably arise, and four years of work largely with l-naphthyl N-methylcarbamate (Sevin) on the variety Rome Beauty have indicated that concentrations ranging from 3X to 33X of this chemical will thin satisfactorily. In most comparisons, the thinning achieved was somewhat inferior to that of dilute applications. However, significant thinning, fruit size increase, and "off" year blossoming was produced at all concentrations. Incorporation of normally used pesticides with Sevin at 6X and 33X in 1965 produced thinning equal to that achieved with Sevin alone. Concentration of naphthalene acetic acid (NAA) plus the surfactant Tween 20 on Golden Delicious apples in one season at rates of 3X, 6X, and 33X produced inferior thinning and significantly inferior "off" year blossoming when compared to dilute applications of this combination, but highly significant results when compared to unsprayed trees. It appears that the economy afforded by concentrate application of thinning sprays is achieved only at the price of reduced effectiveness in thinning action. On the other hand, Sevin in combination with normal pesticides used at that time is just as effective in concentrate application as when applied alone.

Project L-74

To Prune or Not to Prune?

Half of the trees in planting of Redskin peaches made in 1959 have received no pruning after the second year of growth in the orchard, with the exception of removal of broken or dead limbs. The other half of the trees have been pruned in accord with usual practices. In 1962 extreme drought made yield data useless. In the six years since 1962, the annual yield of the pruned trees averaged 232 pounds per tree and the unpruned trees averaged 250 pounds per tree. In the first 3 years the unpruned trees had significantly higher yields. In the last 3 years the yields have been about the same. Fruit on the unpruned trees has been slightly smaller (about 10 percent smaller) than that of the pruned trees. This size difference, although significant in most years, has not been readily apparent, and seems to have been related to crop load. All trees were thinned to what was considered a normal crop load.

There has been no observable effect of lack of pruning on fruit quality. Objective measurement has shown no color differences. The unpruned trees have become "brushy" with the development of small dead limbs in the center but these have not unduly interfered with picking or spraying operations. The overall height of the unpruned trees is no greater than that of the pruned. Limb breakage has been somewhat greater in the unpruned tree but has not been considered serious. At the present time, at the age of ten years, the unpruned trees are showing signs of decline in vigor. It is planned to prune these trees after the 1969 season to determine if normal growth can be restored.

Project L-74

The Magness Pear

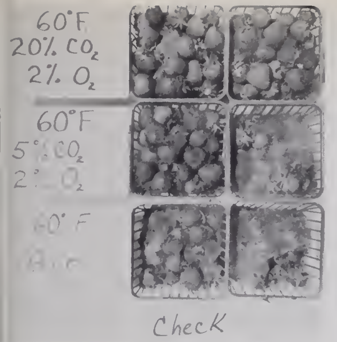
The Magness pear was introduced by the United States Department of Agriculture in 1960 as a high quality, blight resistant variety. The Agricultural Experiment Station planted a block of 100 trees of Magness in 1962 with Bartlett and Moonglow as pollenizers. The Magness trees have grown very satisfactorily and have been completely free from fire blight but fruit production has been very light. The trees produced only a few fruits until 1967 when a light crop was borne. In 1968 there was a complete failure. The reason for light production is not entirely clear. Blossoming has not been adequate and fruit set in this pollen-sterile variety disappointing, although the pollenizers are seemingly coordinated in blossoming. It seems that ideal conditions may be necessary for the setting of a full crop on the variety. Plantings in other parts of the state have encountered similar difficulties.

The favorable factors of high fruit quality and blight resistance of the variety may be negated by failure of consistent fruit production, unless practical measures to improve fruiting can be found.

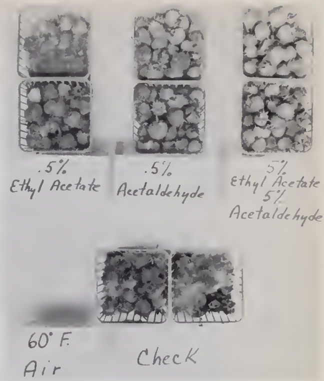
Project L-74

Chemical and Non-Chemical Measures for the Protection of Perishable Food Commodities in Marketing Channels

Losses of fresh fruits and vegetables in the marketing channel due to decay exceed 100 million dollars each year in the United States. Work conducted in the Department of Horticulture to control soft rot, *Rhizopus nigricans,* and gray mold, *Botrytis cinerea,* in strawberries indicates that much of this loss could be prevented. By incorporation of vapors of acetaldehyde and/or ethyl acetate into controlled atmosphere chambers or by inducing the strawberries themselves to produce the 2 volatiles through the use of high CO_2 levels



Top row containers demonstrate control of rhizophus and botrytis obtained when high levels of CO_2 are used versus complete decay in the bottom containers where no CO_2 was used.



Top right containers illustrate complete control of rhizophus and botrytis due to ethyl acetate and acetaldehyde vapors.

both organisms were controlled. The control was very effective even though the berries were held for 5 days at 60°F.

The study indicates that surface sterilization with acetaldehyde, as well as inhibition of spore germination and growth with a low concentration of acetaldehyde plus ethyl acetate on fresh fruit and vegetables, is possible. Additional work is being conducted to develop the techniques necessary for commercial usage to control the major decay causing microorganisms in fresh fruits and vegetables.

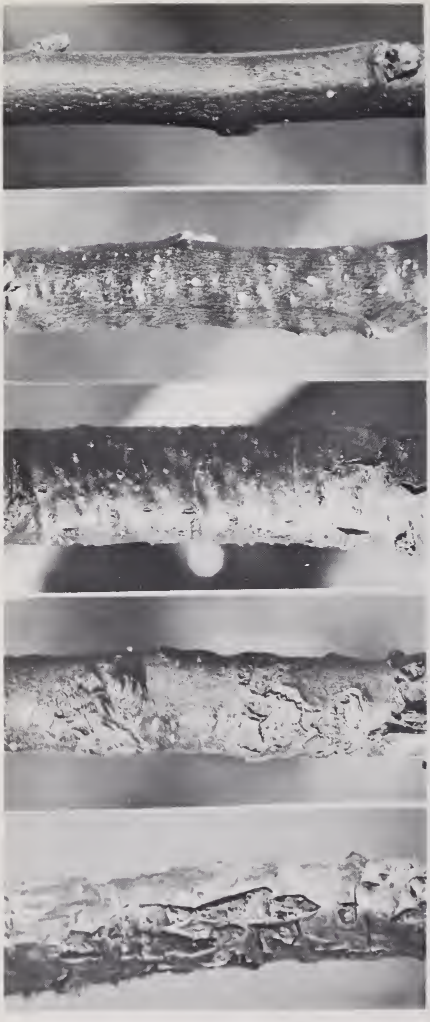
Project L 79g

Mineral Nutrition of the Apple with Special Reference to Calcium, Manganese, and Iron

Broadcasting Lime will not Control Internal Bark Necrosis

Internal bark necrosis (IBN) has plagued the apple grower for many years. Long known to be associated with toxic accumulation of manganese, the disorder (see photos) has been particularly devastating on the leading variety, Delicious, and has failed to respond to the historic recommendation of broadcasting lime in affected orchards.

In a pot culture study in the greenhouse, Red Delicious trees were grown in soil collected from a severely necrotic orchard in Allegany County and from



Progression of symptoms of internal bark necrosis of the apple, variety 'Red Delicious.'

a necrosis-free orchard in Talbot County. Analyses of these trees after two seasons showed a high correlation between manganese concentrations of leaves, bark, and roots with IBN symptoms. By mixing calcium carbonate throughout the rooting medium at planting time, toxic accumulation of manganese and IBN symptoms were obviated. When lime was mixed in the upper half of the rooting medium only, excess manganese was absorbed by the trees and symptoms of IBN developed, though in a lesser degree than in trees growing in a limb-free medium. High soil and leaf potassium concentrations were found to be closely correlated with manganese concentrations in the soil and leaf respectively. Lower roots accumulated more manganese and iron than upper roots in this study. In a separate study involving three different soil types of the state, manganese concentrations were not as important as pH (acidity) and the potassium/manganese ratio in influencing manganese uptake and expression of IBN symptoms. However, as soil manganese was increased, manganese uptake and severity of IBN was increased. Exchangeable manganese in the soil was found to be more important in IBN development than total or reducible manganese.

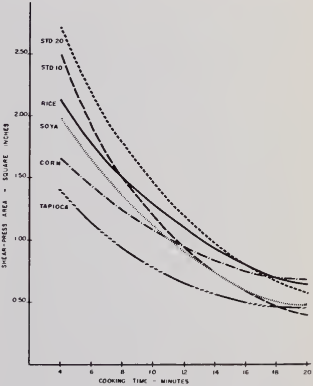
These results demonstarate the futility of liming existing apple orchards to control IBN. Lower roots are more active in absorbing and accumulating and accumulating manganese, and they simply cannot be reached with surface applications of lime. It is apparent also that the potassium/magnesium ratio in orchard soils is important in manganese uptake by Red Delicious apple trees.

Project L-79-h

Development of New Products and Improved Processing Methods

New Pasta Developed from Rice, Corn, Soya and Tapioca Enriched With Fish Protein Concentrate

Fish protein concentrate (FPC) supplemented to flours of rice, corn, soya and tapioca can contribute significantly to the protein intake of the U. S. population as well as the population in developing countries. Both 10 percent and 20 percent FPC additions to pasta were efficient in increasing the protein content and nutritional value of the product. Both sensory and objective evaluations indicated that rice pasta was the most acceptable product. Of corn, soya, and tapioca, pasta and tapioca appeared



Effect of cooking on texture of pasta samples.

most promising for further work because it promoted an attractive color and counteracted grittiness in the FPC. Its texture however, was softest during cooking studies. Sweet potato flour was a useful addition to rice and corn pasta improving appearance, texture and flavor of these products.

Project Q-58-M

Temperature of Treatment Affects Calcium Firming of Sweet Potatoes

Failure to obtain proper textural characteristics, particularly that of firmness of the product, has been one of the major problems in the sweet potato industry. Treatment of the peeled sweet potatoes with calcium solutions prior to processing has been found effective in increasing firmness of the canned product. More recent tests have shown that the temperature of treatment with the calcium solution is an important factor in determining the degree obtained. Greatest firmness was obtained with treatments at 60° C, with both lower and higher temperatures resulting in a softer product. Calcium content of the processed product increased with temperature of the treatment with a pronounced change from 50 to 60° C. It is suggested that the increase in calcium content may be brought about by increased pectinmethylesterase activity making available sites for calcium bonding. This may also explain the rather critical effect of temperature on firmness of the product.

Project Q 58-T

Effects of Day Length and Temperature on Broccoli

Green sprouting broccoli was grown in growth rooms under controlled temperatures and day lengths. Day temperatures of 85°, 75°, and 65° F were used with night temperatures 10° lower than temperatures during the day. Day lengths of 16 and 12 hours were used with each of the controlled temperatures.

The number of days from planting to appearance of the young heads decreased with both shorter days and lower temperatures. Plants grown with a day temperature of 65° F and a 12 hour photoperiod required 81 days from seeding until 50 percent of the plants had visible heads. At a day temperature of 85° F and a 16 hour photoperiod, 124 days were required to reach the same stage of development. Higher rates of nitrogen also tended to decrease the time required for heading.

Quality of broccoli was poor at the 85° temperature due to excessive leafiness of heads and to browning and abscission of flower buds. Heads of desirable type were produced at both the 75 and 65° temperatures.

Project Q-77

New Methods in Handling of Sweet Potatoes

The advent of mechanical harvesting has drastically changed methods of handling crops for both the fresh and processing markets. The sweet potato crop is normally divided between the two markets with the larger sizes designated to the fresh market and the smaller sizes for processing. Since mechanical harvesting would make the present method of field size grading difficult, tests were designed to determine the feasibility of washing and grading sweet potatoes before placing in storage.

The varieties Nemagold, Goldrush, Centennial, and Nugget were used. All potatoes were harvested by present conventional methods and then a part subjected to simulated mechanical harvester injury. The potatoes were then washed using a commercial type brusher-washer, placed in a high humidity curing room at 85° F for 5 days and then held at 60° F at high humidity. The condition of the potatoes after intervals of storage showed great variety differences with Nemagold most susceptible to injury and with greater losses from rotting and weight loss. The other varieties were somewhat comparable with Goldrush showing the least injury. The washed potatoes did not show significantly greater loss from soft rot. The injured and washed lots of Nemagold and Nugget showed more surface rot (*Fusarium oxysporum*) than the control. These varieties are susceptible to this type of rot.

The excellent condition of the washed lots of all varieties except Nemagold even after prolonged storage of 6-8 months indicates the possibility of using washing and grading procedures following mechanical harvesting and prior to placement in storage.

Project Q-77, R-22

Tomato Breeding and Selection with Particular Reference to Adaptation to Mechanical Harvest and to Processing

Successful mechanized harvesting and handling of processing tomatoes is dependent upon the availability of suitable varieties. An important characteristic needed for varieties grown in the Middle Atlantic States is resistance to the anthracnose organism, *Colletotrichum coccodes* (Wall.) Hughes. Anthracnose is a serious disease of processing tomatoes in the Middle Atlantic area, and it may become more serious with the advent of machine harvesting.

Attempts to develop resistant varieties in other tomato production areas have not been successful, possibly because of unreliable artificial inoculation methods used in screening for resistance. Thus, a research study was initiated for the development of a more reliable inoculation method. Several methods were evaluated in preliminary tests, but all except the hypodermic technique gave poor results. This technique involved the placing of a spore suspension droplet onto a fruit with a hypodermic syringe and then pricking the epidermis under the droplet with the hypodermic needle. In further tests conducted with the hypodermic technique, anthracnose lesions developed on 96, 95, and 41 percent of Roma, Heinz 1350, and Plant Introduction 127833 fruits inoculated respectively. The Plant Introduction line had been reported to be resistant to anthracnose, and it was included in the tests to determine disease reaction when the hypodermic inoculation technique was used.

The results obtained with the hypodermic technique indicated the effectiveness of the technique and its usefulness in screening for resistance and determining genetic control of resistance. A genetic study was conducted and results indicated that resistance is quantitatively inherited and is partially dominant to susceptibility. A breeding program is being conducted for the development of anthracnose resistant varieties.

Project Q-81-d

Enzyme Implicated in Corrosion of Tin-lined Cans Used for Processed Fruits and Vegetables

In recent years corrosion or "de-tinning" of tin-lined cans used for processed fruits and vegetables has become an increasing problem. Although the difficulty may be avoided by using enamel-lined cans, the appearance of products in this type of can is often inferior due to the development of dark colored compounds in the absence of the tin coating.

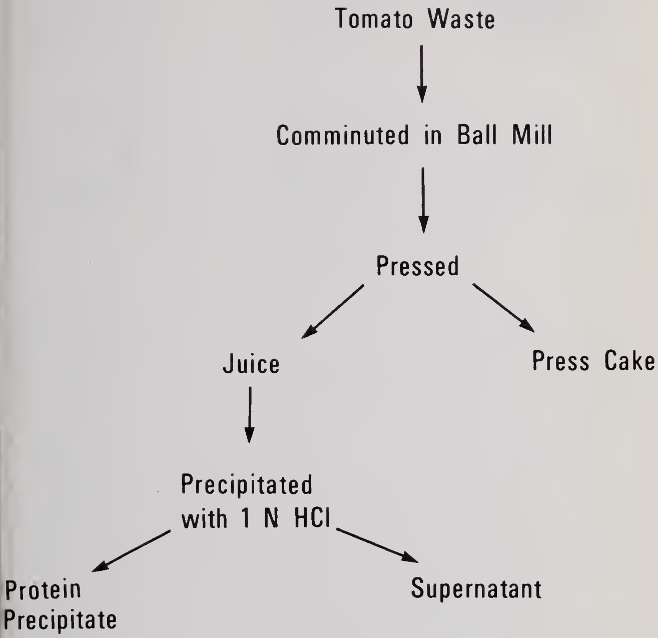
Extreme varietal differences in the severity of corrosion have been noted in sweet potatoes. It has also been shown that the activity of the polyphenolase system in the sweet potato is closely related to the severity of corrosion. When the polyphenolase system was inactivated prior to processing, the amount of corrosion was greatly reduced. In the presence of an active polyphenolase system, the nitrate content of the sweet potato influenced the severity of corrosion, but when the phenolase system was inactivated nitrate content was not important.

It is postulated that activation of the enzyme during the processing procedure initiates the formation of complex compounds which chelate the tin as it is slowly dissolved from the tin plate, thus permitting further attack on the plate.

Project Q-84-b

A Protein Concentrate from Cannery Waste

A world-wide search for new, cheap protein food is in progress through utilization of oil seed residues, hydrocarbons from petroleum and trash fish. At the same time a potential source for thousands of tons of proteins in tomato cannery waste has been overlooked. Tomato waste solids contain 14-22 percent protein. A method of extraction has been developed in which up to 83 percent of the protein can be extracted.



This protein precipitate also contains chlorophyl and other pigments which may be removed by 3 washings of acetone or alcohol. No heat is used in this process, hence no protein denaturation takes place.

The precipitate from the solvent washing can easily be dried at relatively low temperatures into a fine, light gray powder which has exceptionally good functional properties so that it can be used as a protein-nutrient supplement in the manufacture of new and conventional food products.

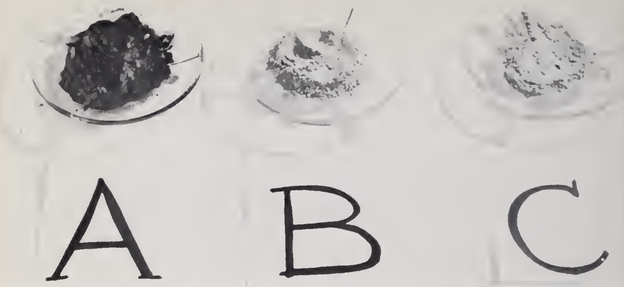


Figure 1. Tomato Cannery Waste Protein
A. Water Extract
B. Acetone Washed
C. Ethyl Alcohol Washed

Project Q-85-a

POULTRY SCIENCE

The poultry industry as a whole has reached a high degree of efficiency both in the production of eggs and in the production of poultry meat. A dozen eggs are regularly produced from less than four pounds of feed, while a pound of live broiler is regularly produced from less than two pounds of feed. These are good goals for the producer but not at all unusual.

In spite of this high degree of efficiency, the industry continues to seek ways of becoming even more efficient in the production of high quality human food, and there is no indication that the ultimate has been attained. It does appear though that many of the simpler problems have been solved, and those which now arise are more difficult and time-consuming. The industry continues to find ways to economize on the use of labor while at the same time providing even better husbandry for their birds. This obviously requires the use of additional capital.

The research areas covered vary widely but generally come under the categories of management, breeding, nutrition and processing. The research carried on by the Poultry Science Department is both of a fundamental and practical nature. However, even the research which is fundamental or basic in nature is problem oriented. Our goal is not simply to add to man's knowledge of the world in which he lives but also concerns solving practical problems.

The research laboratories and field stations of the department are always open for inspection, and we are glad to discuss with interested parties current research data and proposed research projects.

Metabolic and Nutritional Studies on Microorganisms Important to the Poultry Industry

Avian mycoplasmosis, frequently called chronic respiratory disease in chickens and infectious sinusitis in turkeys, is the cause of serious monetary loss to all growers in the United States and other countries. In 1960, the name *Mycoplasma gallisepticum* was given to the pleuropneumonia-like organism (PPLO) which causes avian mycoplasmosis. *M. gallisepticum* can be cultured on a crude medium enriched with serum or serum fraction and is resistant to penicillin, polymyxin and neomycin. A knowledge of the nutritional requirements of *M. gallisepticum,* i.e., culturing the organism on a completely chemically defined medium, would be a tremendous aid in studying the physiology and biochemistry of this organism. Once the nutritional requirements are known, advances in the prevention and control of mycoplasmosis can be made.

The growth factor for avian mycoplasma (PPLO) found in Trypticase has been studied in an extensive fractionation program. Although the chemical nature of this factor has not been worked out, it is found in several peptides from Trypticase and appears to be non-specific.

Studies on the lipid content of worms infecting poultry have also been performed. Our knowledge of lipid relationships of parasites has been revolutionized in the last decade by the application of newer isolation and separation techniques such as thin-layer, column and gas-liquid chromatography. While these newer methods have not yet made all older data obsolete, they do make possible new and promising approaches to the problem. With a knowledge of the lipid content of these poultry parasites, perhaps a better understanding of host-parasite specificity and anthelmintic action of certain drugs can be acquired.

Experiments conducted with *Ascaridia galli,* the common large roundworm found in the intestines of poultry, include infection of chicks with varying dose levels of embryonated eggs, infection of male versus female chickens, and infection of chickens on synthetic diets and antibiotic-free diets.

Experiments with *Heterakis gallinae,* commonly known as the cecal worm, include infection of quail versus chickens, infection of chicks on synthetic diets, and infection of chicks with worms obtained from pheasants. In addition to the lipid analyses of male and female worms of varying age, data were obtained on the parasite recovery per bird, the sex ratio, and the weight of the worms. Data were also obtained on the albumin, globulin, total protein and cholesterol content of sera obtained from infected and noninfected birds.

Project M-58

A Study of Causes of Bruising in Transporation of Live Broilers from Farm to Processing Plant and Possible Methods for Their Reduction

The bruising of broilers continues to be a source of serious economic loss to the poultry industry. Birds that are bruised, even though in otherwise top quality condition, have to be downgraded. This results in a marked decrease in the yield of Grade A birds from any one flock. The labor involved in removing damaged parts is considerable, and often birds have to be sold as parts instead of as a whole bird. Our work in this area has continued in an effort to find factors that relate to the incidence of bruising.

Samples of 6,148 flocks of broilers that had passed through Delmarva poultry processing plants were analyzed for 10 factors related to bruising. Factors found significantly related to bruising included the month and year of production, differences among catching crews and the weight of the birds at the time of sale. Factors studied which did not prove to be related to bruising included the day of the week birds were sold, the number of hours that the birds were held on the pick-up truck and the strain of birds being used. In this study, approximately 39 percent of the bruises were on the breast area of the birds, 30 percent on legs and thighs and 31 percent on the wings.

Project M-61

Effects of Gonadal Hormones on Embryonic and Postnatal Bone Growth in Chickens

In the domestic fowl, males weigh approximately 25 percent more than females as the birds approach maturity. In an effort to understand the basic physiological reasons for this sexual dimorphism in body weight, chicks from a sex-linked cross were treated at various ages with androgen, estrogen or the combined hormones.

Treatment with androgen alone resulted in increased comb growth but caused no changes in body weight or in growth of the long bones. Estrogens alone caused increased fat deposition in both sexes but there were no changes in bone or body growth, exclusive of the increased fat. However, treatment with the combined hormones resulted in a decreased growth of the long bones in both sexes without a reduction in body weight. Sexual dimorphism for bone growth was reduced considerably by treatment with the combined androgen and estrogen.

Changes in blood calcium, phosphorus, and alkaline phosphatase indicated that these are apparently physiologically independent of the mechanism causing the shortening of growing long bones. Estrogen alone and the combined treatments resulted in a brief increase in serum calcium. There were erratic but non-significant changes in both serum phosphorus and alkaline phosphatase as a result of estrogen and the combined treatment.

Additional studies will be conducted in order to attempt to further delineate physiological changes which cause this reduction in bone length.

Project M-64

Applied Broiler Nutrition Studies

Upgraded specifications for formulating broiler starting rations, growing rations and finishing rations have been published based on improved nutrient composition data and the most recent University of Maryland studies on amino acid requirements. A computer program has been written in "MAD" for the calculation of the levels of essential amino acids, protein, and calcium in rations for laying hens where performance characteristics and environment are considered in the calculation.

Several equations based on earlier research at the University of Maryland dealing with requirements for energy, lysine, and methionine by laying hens as a function of temperature have been combined with other assumptions to develop a markedly improved means of estimating dietary levels to accompany specified energy contents. Body weights, weight gains, egg production level, egg size, energy content of the feed, temperature and the protein quality index factor are considered. Adjustment of the ration in keeping with changes in temperature offers a considerable economic opportunity in the production of eggs.

A similar computer program has been written to estimate the requirements of broilers but this is satisfactory only for broiler starting rations. The data upon which these calculations are based were obtained using chicks under four weeks of age. Extrapolation of the relationships found with amino acid utilization and carcass composition leads to an overestimation for broiler finishers of approximately 10 percent. This calculation is based on equations also developed at the University of Maryland relating the methionine, total sulfur amino acid, and lysine requirements of young chicks to amount of carcass protein maintained and gain in carcass protein as a function of carcass composition expressed as nitrogen on a dry basis.

Three studies were conducted to determine the range of optimum sodium levels in broiler starting and finisher diets. These results show that a 0.14 percent sodium level was adequate for growth but feed conversions were improved slightly up to .17 percent. It seems possible that some practical rations, low in fish meal, could have been slightly suboptimal in sodium. These studies required the analysis of several practical ingredients for sodium content and the development of improved composition data of feed ingredients with respect to sodium.

Two studies were also conducted to study the relationship of calcium level on phosphorus requirement and to insure that the University of Maryland recommendations were sound. In addition, floor pen studies were also conducted during the year on the effect of added selenium and potassium to practical simplified broiler rations. Both studies yielded negative results although it is believed that under some conditions in Delmarva, selenium may be deficient. The possibility that potassium may also be deficient under stress conditions also appears realistic but more work is required under diseased stress conditions.

A chick bio-assay was developed and described for determining the availability of sodium in defluorinated rock phosphate. The chick bio-assay using the parallel line assay technique was conducted. It was found that the availability of this product was approximately 82.9 percent.

Project M-66

Inheritance of Lysine Utilization

Genetic variations in nutrient requirements have been known to exist for a number of years, but these variations have been demonstrated on a qualitative rather than a quantitative basis. During the past five years, a strain of Japanese quail has been developed which requires only 70 percent of the normal lysine level to grow, live and reproduce normally. Fifteen generations of selection on these quail have been completed. Initially, response was quite slow. After the tenth generation, the low lysine line showed significant differences in growth from the random-bred control line. These results demonstrate that genetic differences do indeed exist in the ability to utilize the amino acid, lysine. The genetic control of this trait also exhibits a very low heritability, many pairs of genes being involved in the mode of inheritance.

Project M-70

Quality Retention in Poultry Meats as Influenced by Methods of Processing

Shelf life and cooking characteristics were compared with broilers that had been packaged in four different ways. These included a non-evacuated bag, evacuated but not heat-shrunk bag, an evacuated heat-shrunk bag, and evacuated heat-shrunk wax-coated bag. Dressing losses from birds packed in the evacuated bags were lower than those of birds from the non-evacuated bags.

Differences in total aerobic bacterial counts for birds packaged by the four methods were considered unimportant when birds were stored up to 14 days. The odor scores, determined objectively, indicated that the wax coating of the evacuated packages delayed somewhat the development of objectionable odors. The birds in the evacuated heat-shrunk wax-coated packages had more eye appeal than those packaged with the other treatments.

The shelf life of dressed poultry was determined with and without the inclusion of the wrapped giblets. The inclusion of the giblets had little influence on shelf life. However, this inclusion did increase drip loss, and it is felt that their removal from the retail pack would provide a more attractive retail package.

Project M-100

Studies of the Influence of Slush-ice Chilling and Carcass Water Content on the Quality of Processed Poultry

Slush-ice chilling increases carcass weight by the addition of water to the carcass. The later loss of this water during ice-pack storage makes it difficult to maintain net weights through market channels. The influence on carcass weight changes of ice partical size, grams of ice/grams carcass weight, and position of the carcass in the shipping container, has been studied.

Individual variation in changes in weight have been so large that they mask treatment effects. However, a statistically significant influence has been expressed regarding carcass position in the shipping container. This influence has been observed in each trial but has not been the same position from one trial to the next.

Project M-101

Studies of Factors Influencing Broiler Carcass Yields, and Microflora of Processed Broilers

Strain differences may influence parts yields of cut-up broilers. A standard cutting procedure has been established. Pilot in-plant trials indicate that more basic laboratory information is needed before satisfactory field studies can be accomplished.

Salmonella contaminated processed broilers constitute a public health problem. A five month in-plant study was conducted to estimate the level of *Salmonella* contamination of incoming poultry and outgoing product in a Maryland processing plant. Of the 300 samples taken from incoming poultry, 3.6 percent were *Salmonella* positive. Twenty-five percent of 135 samples taken from final product were *Salmonella* positive.

Project M-102

Study of Chick RBC Transketolase as an Index of Thiamine Nutriture

Studies have been continued on the quantitative effect of the percent of fat calories in the ration on the requirement of the chick for thiamine. This work has led to studies dealing with the interaction of biotin and thiamine under certain metabolic conditions. Specific enzyme pathways have been studied including transketolase activity of red blood cells in this work. It appears that the requirement for thiamine in metabolism of fat is approximately one half that required for metabolism of carbohydrate when expressed on a calorie basis.

Project M-207

Use of Chick Bio-assay in Measuring Specific Amino Acid Availability

Improved chick bio-assays have been developed which consider differences in feed intake in the measurement of availability of lysine and methionine. Approximately 15 experiments, each consisting of from 60 to 96 replicated groups of 8 chicks each, have been conducted during the year. Accordingly, data have been developed on large numbers of important practical feed ingredients including some 60 different samples of fish meals.

Apparent amino acid digestibility determinations indicated that the microbial rearrangement and synthesis of amino acids in the lower intestine and caeca did not permit accurate estimates of amino acid availability. Accordingly, an investigation was conducted collaboratively with the Bureau of Commercial Fisheries in which the recovery of amino acid from ileal contents of the chicken was used as an index of availability. Essentially all of these indispensable amino acids from casein were found to be absorbed from ileal contents. About 80 percent of the amino acids from good quality fish meals similarly were absorbed. Severely heat-damaged fish meal was essentially indigestible, almost all being found in ileal contents. This study suggests that the recovery of amino acids from the ileum might represent a sensitive index of protein quality without being confounded by caeca and intestinal bacterial action. Additional work is required, however, to establish that such a procedure would serve as a useful tool in evaluation of amino acid availability from various protein sources.

Feed analysis data obtained from the Maryland State Feed Control Laboratory and different commercial companies in Maryland were summarized and an updated, improved nutrient composition table published. This table includes available amino acid data based on both determined and estimated values. A computer program has also been written by the Poultry Science nutrition staff and made available to industry groups and others for processing of feed ingredient data. This program adjusts the mean by one half standard deviation prior to use in practical ration formulation.

Project M-208

Effect of Protein Level and Amino Acid Balance on Voluntary Feed Consumption

Three battery studies with chicks under four weeks of age have revealed marked effects of body composition of chicks on subsequent voluntary appetite. Either a deficiency or an excess of methionine was found to depress the amount of feed consumed and body weight gain. Chicks maintained at low temperature, regardless of their initial body composition, were able to increase their consumption of methionine-low diet and their weight gain.

Obese chicks consumed significantly less feed than their non-obese counterparts, regardless of the ambient temperature or the methionine content of the diet. Similarly the rate of growth of the obese chicks was lower than the non-obese ones on the same diet. Obese chicks consumed significantly less feed than their non-obese counterparts, regardless of the ambient temperature or the methionine content of the diet. Similarly the rate of growth of the obese chicks was lower than the non-obese ones on the same diet. Obese chicks fed an adequate methionine diet tended to consume near normal amounts of feed, gain weight, lose their body fat and return to a normal body composition within approximately two weeks. Body composition appeared to exert an important role in regulating the voluntary feed intake of the chick.

The methionine-deficient and methionine-excess diets were used as a means of studying amino acid imbalances in this work. Chicks varying from 1.7 to 26 percent of body fat, but of the same age, were used in this work.

Lysine-low diets, consisting primarily of corn and hydrolyzed feather meal, have been successfully used to retard the sexual maturity of broiler-breeder pullets, thereby increasing the initial egg size and number of total eggs which can be used for hatching purposes. During the past year, a total of eight treatments were studied including lysine-low diets varying in energy content, lysine-low diets varying in protein content, skip-a-day feeding of a complete ration and a control complete ration. All treatments were successful in reducing body weight of treated birds below that of controls at 20 weeks of age.

Studies are being continued on the effect of energy restriction on egg production, hatchability, egg size and other production characteristics of broiler breeder hens during the first year of production. This practice is frequently employed but the evidence for its use is not apparent. This study is of considerable importance to the broiler industry in Maryland.

Project M-209

Determination of Amino Acid Requirements of Growing Broiler Chicks and Laying Hens

During the past year, two floor pen studies have been conducted on glycine requirements of broiler chickens, the results of which have shown that the glycine level is not of critical importance in practical ration formulation, at the present time. In addition, three experiments have been conducted on the lysine requirement of chicks by weekly periods. In addition, two studies have been conducted in floor pens during this past year dealing with the lysine requirement of broiler chicks to four weeks of age.

The glycine requirement in the period from four to eight weeks has been studied in four different floor pen trials at the University of Maryland Salisbury substation. Moreover, current University of Maryland amino acid recommendations for broiler starters and broiler finishers have been tested and found to be adequate in two floor pen studies.

Battery studies involving various levels of folacin in combination with different levels of hydroxybenzoic acid, with chicks having been depleted in folacin, have indicated that folacin is required for the conversion of hydroxybenzoic acid to CoQ. The use of radioactive hydroxybenzoic acid in collaborative studies with Stanford Research Institute has further supported this finding. Oral administration or injection of CoQ was able to completely prevent the severe anemia associated with the folacin deficiency.

At the present time, broiler breeder pullets are being fed growing rations varying in total choline content from approximately 420 to 840 milligrams per pound. Since choline is involved in lipid transport, this study is being conducted to be certain that higher levels of choline will not tend to reduce liver fat content and increase livability of breeder hens. The same treatments are being continued throughout the first laying year. In addition, inositol, a compound closely related to choline and also involved in the formation of phospholipids, is being added in addition to the highest choline level in order to see if this may have an effect. Recent work suggests that inositol may be helpful in reducing liver fat and improving livability of laying hens in batteries. This study is designed to determine if inositol and adequate choline levels may be beneficial for heavy breeder hens.

Project M-210

The Relationship between Cathepsin Level and Leukosis

The leukosis complex continues to be the most important killer of poultry. This project is an attempt to determine the chemical basis for genetic differences in susceptibility to leukosis, with the hope of finding a simple blood test for use in selecting the most resistant birds at an early age. One blood enzyme, cathepsin, appears promising at this time. Selection of two lines, one with a high level and a low level of this enzyme, has been undertaken. A breeder flock for the third generation of offspring has been selected on the basis of their cathepsin levels at six weeks of age. Considerably more information is needed before any conclusions can be made.

Project M-303

Selection for Viability of Broiler Breeding Stock

To study the feasibility of combining high viability with economic traits of high importance, a study has been initiated at the Salisbury substation in the heart of the broiler industry to develop a male line under rather adverse environmental conditions. A synthetic strain was produced by crossing commercially available broiler birds. This strain is in the third generation of selection, the progeny having been grown under a rather high natural disease load combined with artificial inoculation with the organism producing Marek's disease. The total of 20 individual male matings are employed per generation and a total population of approximately 2,000 are grown per generation. Annually these birds are compared with the Athens Randombred strain of broiler birds which is serving as the control to determine how much progress has been made in increasing viability. Selection is being based both on a sire and dam family. However, difficulty has been encountered in inducing these large broiler-type females to use the trapnest, and under these circumstances only the sire can be recorded. Breeding is currently being done under floor pen conditions. Moving the birds to laying batteries and using artificial insemination is being seriously considered at the moment.

Project M-304

Genetic Basis for Resistance to the Avian Leukosis Complex

Fundamental studies are being pursued relative to the causative agent(s) for Marek's disease. Identification and further study of the agent(s) is obviously a prerequisite to the development of control measures for the disease. An agent producing Marek's disease (acute or type II leukosis) was isolated from the heart blood of a 7-month-old Athens Randombred rooster being used in this study. The only lesion observed on necropsy was a slight enlargement of the sciatic nerves. A 0.1 ml quantity of blood was inoculated into each of 16 7-day-old chicks from the Cornell leukosis susceptible (S) line. Paralysis was observed in one chick 15 days postinoculation. All of the inoculated birds succumbed by the 19th week.

Eight bird passages have been made using similar techniques. Paralysis is usually produced in 20 to 40 percent of the birds by the fifth week postinoculation. Most of the birds show gross evidence of visceral tumors, usually enlargement of the proventriculus or ovary and small gray nodules on the surface of the heart. By the time the birds are 10 weeks of age, 80 to 90 percent are affected. A more malignant type characterized by diffuse lymphoid infiltration of the lungs, proventriculus, liver, spleen and kidney has been observed. Attempts are being made to purify the virus by propagation in chicken and duck tissue cultures.

Project M-305

VETERINARY SCIENCE

Respiratory Diseases of Poultry

In studies of field outbreaks of respiratory diseases, the direct fluorescent antibody (FA) test was used to detect the presence of Newcastle disease viral antigen in the trachea of chickens. The FA test agreed with virus isolation results in 47 of 48 consignments compared. The virus was found in one consignment where the FA test was negative. A similar test was used to detect the presence of infectious bronchitis (IB) and infectious laryngotracheitis (ILT) infections. There was agreement in 50 of the 58 consignments when the direct FA test was compared with IB virus isolation and 53 of the 56 consignments of ILT. This test has been shown to be reliable and is a much faster test than virus isolation and serum neutralization.

A total of 114,941 chickens, representing 1,348 flocks, were tested for *Mycoplasma gallisepticum* (MG). Of these, 1,455 birds (1.26 percent) were positive. This represents a 74.3 percent decrease in positive reactions from a year ago. This decreased incidence of MG infection is also reflected in the decreased incidence of processing plant condemnations for airsacculitis and septicemia-toxemia.

Project D-52

A Study of the Epidemiology of Staphylococcal Mastitis (Bovine) Utilizing Phage Typing

General herd surveys on 2,229 dairy cows in Maryland showed 2,268 quarter samples positive for pathogenic bacteria out of 8,856 quarters tested.

A study on the use of erythromycin as an intramammary infusion showed it to be highly effective for treating *Streptococcic* and *Staphylococcic* mastitis.

Twelve bovine phage were used to type 890 hemolytic coagulase positive *Staphylococci* isolated from the udder. No particular phage pattern was observed for the state in general.

Several herds that have been shedding high numbers of hemolytic coagulase positive *Staphylococci* after vaccinating biannually with a commercial toxoid show a significant decrease in this type of *Staphylococci* and a decrease in clinical mastitis.

Project D-58

Fluorescent Antibody Technique in Respiratory Diseases of Poultry

Fluorescent antibody conjugates were prepared for the detection of *Mycoplasma gallisepticum* (MG) in the respiratory system of infected chickens. This conjugate also works well for the identification of MG grown on agar plates and in culture media. A similar conjugation procedure was used to prepare a conjugate for the detection of *Mycoplasma synoviae* (MS). These two conjugates appear to be specific for their respective antigens.

The indirect fluorescent antibody test is being evaluated for detecting the presence of antibodies to Infectious Bronchitis (IB). Using the trachea of chickens infected with IB as a source of antigen proved unsatisfactory. Excessive nonspecific staining was encountered. This may have been due to immunoglobulins (IGA) secreted by the epithelial cells of the trachea. IB infected chicken kidney cells grown on cover slips are now being evaluated as an antigen source.

Project D-59

Study of Bovine Respiratory Diseases

Three bovine respiratory disease outbreaks were investigated during the year. Seventy-three specimens were tested for virus isolation and 263 serums for antibodies. Infectious bovine rhinotracheitis virus was isolated from 9 specimens. Sixty-three serums were positive for IBR and 40 for parainfluenza-2 (SF-4) virus.

The effect of bovine rhinovirus isolate, C-07, was studied in experimentally infected young calves. The virus produced clinical symptoms typical of a respiratory disease in infected calves. Pneumonia of varying severity was observed in the lungs of these calves on necropsy and histopathologic examination. Few calves which had no clinical symptoms had pneumonia at necropsy.

Bovine rhinoviruses cause signs of respiratory disease in young calves.

This study indicated that bovine rhinoviruses could play an important role in the bovine respiratory disease complex.

Preliminary studies were also conducted with bovine adenovirus types 4, 5 and 6 obtained from Hungary. These types grew only in calf testicular cell cultures and shared no common group specific complement-fixing antigen with types 1 - 3 and human adenoviruses. All other characteristics however, confirmed them to be adenoviruses. A serological survey indicated that antibodies to types 4, 5 and 6 bovine adenoviruses were highly prevalent in the cattle population of Maryland.

Project D-63

Bovine adenovirus grow only in calf testicular cell cultures.

An Investigation to Study the Propagation of Avian Viruses in Tissue Culture

The infectious bronchitis (IB) virus, which causes significant economic losses to the Maryland poultry industry, is being studied with new techniques. In the past it has been necessary to investigate the characteristics of the virus by infecting embryonating eggs. The virus is now being grown and studied in cultures of segments of chicken tracheas. These cultures are being used to compare the relative merits of tracheal cultures and embryonating eggs for the titration of IB virus and for cross neutralization tests with strains of the virus.

It is hoped that the propagation of the virus in tracheal sections will serve to maintain the strains in an unadapted state and that neutralization lines derived from data obtained with tracheal rings will give sharper end points and reveal more meaningful differences than are obtained in eggs.

The results of the titration of virus in tracheas from chickens which have recovered from experimental infection as compared to tracheas from susceptible birds is being used to study the extent to which cellular immunity is a factor in resistance to infection.

Project D-64

During this period, 10 newborn calves were added. Of these, 3 were inoculated with emulsion of murine lymphosarcoma (MLS) and treated with urethan (TWU), 3 were TWU only, and 4 were used as controls. Blood specimens continued to be tested monthly.

Of 8 animals which had been inoculated with bovine lymphosarcoma material (BLS), 2 (1 given BLS *per os* and 1 inoculated in the jugular vein with tissue culture) continued to show circulating lymphoid cells (CLC) at positive levels (lymphocytosis), 5 had CLC fluctuating between positive and suspicious levels, and 1 had CLC counts at negative levels, during the fifth and sixth years of observation.

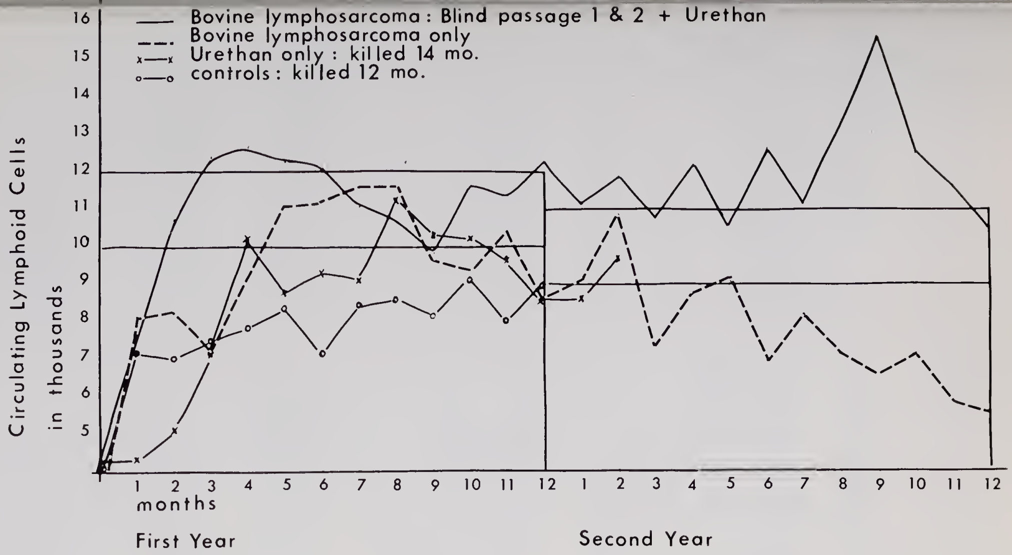
Four animals previously inoculated with second blind passage (P_2) of BLS and TWU, 1 of which had had positive and 3, suspicious reactions during the first year, all developed lymphocytosis during the second year. Of 5 other animals previously inoculated with BLS-P_2 but not TWU, one had a lymphocytosis during the 1st year and all had negative reaction during the second year.

Likewise, of 3 other calves inoculated with MLS and also TWU, all had had suspicious reactions during the first year and 1 became positive during the second year. Of 9 calves previously inoculated with emulsion of MLS only, 1 had CLC at positive and 4 at suspicious levels during the second year. Four had CLC at positive and 4 at suspicious level during the first year.

Calves TWU, alone, did not show a significant rise of CLC during the first year, after which observation was discontinued.

Necropsy and microscopic examination of sections of specimens taken from all organs of the 35 animals slaughtered revealed no neoplasia. However, cortical hyperplasia and blast cells in the sinuses of the lymph nodes were noted in animals inoculated with BLS or MLS and TWU.

Using a coulter for determining the number of blood cells.



CIRCULATING LYMPHOID CELLS IN CALVES INOCULATED WITH BOVINE LYMPHOSARCOMA

Project D-65

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Agricultural and Extension Education

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J. W. Longest. Ph.D., Assoc. Prof.
C. R. Smith, Ed.D., Assoc. Prof.
A. H. Krebs, Ph.D., Prof.
E. R. Ryden, Ph.D., Prof.

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G. W. Gienger, M.S., Assoc. Prof.
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M. K. Aycock, Jr.. Ph.D., Asst. Prof. Plant Brdg.
D. F. Bezdicek. Ph.D., Asst. Prof. Soils
S. R. Colby, Ph.D., Asst. Prof. Crops
A. M. Decker, Jr., Ph.D., Prof. Crops
L. R. Fernow, Ph.D., Asst. Prof. Geology
J. H. Hoyert, Ph.D., Assoc. Prof. Tobacco
R. G. Rothgeb. Ph.D., Prof. Plant Breeding
Edward Strickling, Ph.D., Prof. Soil Physics
J. H. Axley, Ph.D., Prof. Soils
V. A. Bandel, Ph.D., Asst. Prof. Soils
N. A. Clark, Ph.D., Assoc. Prof. Crops
E. E. Deal, Ph.D., Asst. Prof. Crops
D. S. Fanning, Ph.D., Asst. Prof. Soils
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J. V. Parochetti, Ph.D., Asst. Prof. Weed Control
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O. D. Morgan, Jr., Ph.D., Assoc. Prof. Plant Pathology
G. W. Patterson, Ph.D., Asst. Prof. Plant Physiology
H. D. Sisler, Ph.D., Prof. Plant Pathology
R. A. Galloway, Ph.D., Assoc. Prof. Plant Physiology
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C. R. Curtis, Ph.D.. Asst. Prof. Plant Pathology
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T. P. Fairchild. Ph.D., Asst. Prof. Genettics
Mark Keeney, Ph.D., Prof. Mfg.
J. F. Mattick, Ph.D., Prof. Mfg.
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Editorial

C. W. Jackson, M.S., Agr. Ed.
Dorothy Conant, B.S., Inform. Spec.

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B. L. Rogers, Ph.D., Assoc. Prof. Pomol.
J. B. Shanks, Ph.D., Prof. Flor.
A. H. Thompson, Ph.D., Prof. Pomol.

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Mrs. Mary S. Shorb, Ph.D., Res. Prof. Poultry Nutr.

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S. B. Mohanty, D.V.M., Ph.D., Asst. Prof. Vet. Virology
J. A. Newman, D.V.M.. Ph.D., Assoc. Prof.
F. K. Wills, V.M.D., Ph.D., Assoc. Prof.
T. F. Albert, V.M.D., Asst. Prof.
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Elizabeth J. Schultz, V.M.D., Asst. Prof. Mastitis Res.
R. B. Shillinger, D.V.M., Assoc. Prof.

FINANCIAL STATEMENT — JULY 1, 1967 TO JUNE 30, 1968

	Federal Funds			
	Hatch Amended	*Regional Research*	*Forestry McIntire-Stennis*	*For Agric. Investigations**
Appropriations 1967-1968	$553,798.00	$168,538.00	$45,471.00	
TOTALS	553,798.00	168,538.00	45,471.00	
Receipts from sources other than Federal 1967-1968				
State Appropriations for Agricultural Investigations				$1,887,309.00
Special Endowments, Fellowships and Grants				83,743.01
Sales & Miscellaneous				255,389.54
			Total	$2,226,441.55
Balance brought forward July 1, 1967				34,629.86
TOTAL				$2,261,071.41
Expenditures:				
Personal Services	$482,201.77	$ 86,294.52	$41,603.87	
Travel & Transportation	918.28	4,644.26	989.91	
Equipment	16,157.44	34,427.39	638.04	
Lands & Structures	----	3,093.25	----	
Supplies & Materials	28,344.03	27,313.70	1,980.61	
All other	26,176.48	12,764.88	2,109.00	
TOTAL	$553,798.00	$168,538.00	$47,321.43	
Balance on June 30, 1968			2,062.31	
TOTALS	$553,798.00	$168,538.00	$49,383.74**	

**Includes $2,062.31 Holdover Funds

*Including Offset Funds

PUBLICATIONS

1967-1968

Technical Bulletins

A154 Maryland Agricultural Experiment Station Publications, July 1, 1960 - June 30, 1965. I. C. Haut. 23 pp. August 1967.

A157 Survey of Agricultural Research in Maryland. Seventy-ninth Annual Report of the Maryland Agricultural Experiment Station 1965-66. I. C. Haut. 156 pp. Nov. 1967.

Miscellaneous Publications

666 A Report on the Problem of Damage to Agricultural Crops by Wildlife in Maryland. G. M. Cairns and B. A. Twigg. Multilithed Circular. 27 pp. February 1968.

DEPARTMENT OF AGRICULTURAL ECONOMICS

Scientific Articles

A1334 Private and Public Farm Manpower Policy Implications of the Dairy Farm Labor Resource Adjustment Process. John W. Wysong. Ag. Econ. Mimeo Series 23. 17 pp. July 1967.

A1425 Factors Affecting Labor Use and Worker Productivity on Efficient Dairy Farms. John W. Wysong. Ag. Econ. Mimeo Series No. 27. March 1968. 8 pp.

A1426 Profitability Planning for Comercial Milk Production. John W. Wysong. Ag. Econ. Mimeo Series No. 26. March 1968. 18 pp.

A1427 Simulating Population Growth in Rural Uganda. Phillips Foster and Larry Yost. Ag. Econ. Mimeo Series No. 29. April 1968. 16 pp.

A1432 Long-Term Adjustments by a Panel of Mid-Atlantic Dairy Farm Firms to Improve Their Business Efficiency and Profitability. John W. Wyson. Ag. Econ. Mimeo Series No. 29. April 1968. 16 pp.

A1433 Labor Productivity and Labor Force Characteristics of Selected Types of Commercial Farms. John W. Wysong. Ag. Econ. Mimeo Series No. 28. April 1968. 27 pp.

A1445 Some Long-Term Developments in the Dairy and Beef Cattle Industries in the United States, the Northeast and Maryland. John W. Wysong. Ag. Econ. Mimeo Series No. 31. May 1968. 27 pp.

Miscellaneous Publications

616 Agriculture and Trade of the European Economic Community. Levon Yeaganiantz and John R. Moore. Multilithed Circular, 84 pp. Oct 1967.

621 Population Growth and Rural Developmen in Buganda—A Simulation of a Micro-Socio-Economic System. Phillips Foster and Larry Yost. Multilithed Circular, 87 pp. April 1968.

623 The Structure of Plantation Agriculture in Jamaica. Phillips Foster and Peter Creyke. Multilithed Circular, 102 pp. May 1968.

627 The Transfer of Farm and Open Country Real Estate in Garrett County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 25 pp. July 1967.

628 The Transfer of Farm and Open Country Real Estate in Frederick County, Maryland, 1964. Ray A Murray and Edwin I. Cissel. Multilithed Circular, 47 pp. July 1967.

629 The Structure of Shifting Agriculture in Two Chewa Villages. Dean F. Tuthill, John A. Williams, and Phillips W. Foster. Multilithed Circular, 55 pp. May 1968.

630 The Transfer of Farm and Open Country Real Estate in Montgomery County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 21 pp. August 1967.

631 The Transfer of Farm and Open Country Real Estate in Prince Georges County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 33 pp. August 1967.

632 The Transfer of Farm and Open Country Real Estate in Queen Anne's County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 25 pp. August 1967.

633 The Transfer of Farm and Open Country Real Estate in Howard County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 25 pp. August 1967.

634 The Transfer of Farm and Open Country Real Estate in Kent County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 29 pp. August 1967.

635 The Transfer of Farm and Open Country Real Estate in Harford County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 29 pp. August 1967.

636 Farm Level Marketing of Maryland Produced Tomatoes, Sweet Corn and Green Beans for Fresh Market, 1965. Multilithed Circular, 32 pp. May 1968.

639 Farm Ownership Valuation and Taxation in Rural-Urban Maryland. Wm. Paul Walker. Multilithed Circular, 27 pp. Dec. 1967.

640 Market Structure of Timber Producers in Handling Forest Products in Maryland. James O. Burnett and Harold D. Smith. Multilithed Circular, 46 pp. Sept. 1967.

641 Institutional Changes Affecting Milk Marketing Practices in the Washington, D. C. Area. G. M. Beal and Nathan Drown. Multilithed Circular, 51 pp. June 1968.

643 Recent Trends in Tax Resources of County Governments in Maryland. Wm. Paul Walker. Multilithed Circular, 19 pp. March 1968.

644 Economies of Size in Selected Affiliated Wholesale Food Marketing Firms—1963. Jarvis L. Cain and Jack L. Runyan. Multilithed Circular, 11 pp. May 1968.

645 Market Structure of the Sawmill Industry in the Handling of Forest Products in Maryland. Harold D. Smith and James O. Burnett. Multilithed Circular, 19 pp. April 1968.

647 The Transfer of Farm and Open Country Real Estate in Somerset County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 29 pp. Oct. 1967.

648 The Transfer of Farm and Open Country Real Estate in Talbot County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 25 pp. Nov. 1967.

653 The Effects of Sediment Pollution on Water Recreation in the Upper Potomac Estuary. Dean F. Tuthill, David Sobers, and J. Paxton Marshall. Multilithed Circular, 62 pp. Dec. 1967.

655 The Transfer of Farm and Open Country Real Estate in Wicomico County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 29 pp. Nov. 1967.

656 The Transfer of Farm and Open Country Real Estate in Washington County, Maryland, 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 33 pp. Nov. 1967.

658 The Transfer of Farm and Open Country Real Estate in Worcester County, Md., 1964. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 27 pp. Dec. 1967.

DEPARTMENT OF AGRICULTURAL ENGINEERING

Scientific Articles

A1404 Field Studies on Flaming for Control of the Alfalfa Weevil in Maryland—1967. W. L. Harris, C. C. Blickenstaff, N. A. Clark, and J. W. Neal. Paper Presented at Fifth Annual Symposium on Thermal Agriculture, Memphis, Tenn. Jan. 24-25, 1968. Pp. 26-39.

A1412 Effects of Air Temperature, Velocity, and Time of Exposure on the Alfalfa Weevil. R. M. Coan and W. L. Harris. Paper Presented at Fifth Annual Symposium on Thermal Agriculture, Memphis, Tenn. Jan. 24-25, 1968. Pp. 40-43.

A1413 Design of an LP-Gas Burner for Field Flaming. W. L. Harris. Paper Presented at Fifth Annual Symposium on Thermal Agr. Jan. 24-25, 1968. Pp. 16-19.

DEPARTMENT OF AGRONOMY

Miscellaneous Publications

654 Maryland 64—A High Yielding, Later Maturing Variety of Maryland Tobacco. C. G. McKee. Multilithed Circular. 4 pp. March 1968.

Scientific Articles

A1377 Effect of Soil Nutrients and pH on Nitrate Nitrogen and Growth of Pearl Millet (*Pennisetum typhoides* (Burm. Stapf and Hubbard) and Sudangrass (*Sorghum sudanense* (Piper) Staph). D. T. Smith and N. A. Clark. Agronomy Journal 60:38-40. Jan.-Feb. 1968.

A1355 Evaluation of Selected Alfalfa Clones for Resistance to *Sclerotinia trifoliorum* Ericks. J. H. Elgin, Jr. and E. H. Beyer. Crop Science 8:265-266. March-April 1968.

A1410 Germination (Emergence) of Tobacco Seed and Its Relationship to Total Soluble Salts as Measured by Electrical Conductivity of the Soil. J. H. Hoyert. Tobacco Science 12(3):33-36. March 1, 1968.

DEPARTMENT OF ANIMAL SCIENCE

Scientific Articles

A1323 Determination of the *in vivo* Rate of Progesterone Secretion by the Ovary of the Pig During the Luteal Phase of the Estrous Cycle. H. J. Brinkley and E. P. Young. Endocrinology 82(2):203-208. February 1968.

Miscellaneous Articles

671 Early Dietary Influences on Swine Growth and Carcasses. W. R. Bounds and E. P. Young. 1968 Md. Nutrition Conf. Feed Manufacturers Proc. March 28-29, 1968. Pp. 65-73.

DEPARTMENT OF BOTANY

Scientific Articles

A1276 Sterols of Chlorella. II. The Occurrence of an Unusual Sterol Mixture in *Chlorella vulgaris.* G. W. Patterson. Plant Physiology 42(10):1457-1459. Oct. 1967.

A1309 The Effect of Culture Conditions on the Hydrocarbon Content of *Chlorella vulgaris.* Glenn W. Patterson. J. of Phycology 3:22-23. 1967.

A1344 Factors Regulating Toxicity of Cycloheximide Derivities. H. D. Sisler, M. R. Siegel, and Nancy N. Ragsdale. Phytopathology 57(11):1191-1196. Nov. 1967.

A1346 Formation of Fungitoxins in Wound Sap of Phaseolus Lunatus. A. A. Bell. Phytopathology 57(10):1111-1115. Oct. 1967.

A1357 New High Temperature Chlorella. Constantine Sorokin. Science 158(3805): 1204-1205. Dec. 1, 1967.

A1360 Fucosterol Reduction to Clionasterol *in Vivo* by *Chlorella ellipsoidea.* G. W. Patterson and E. P. Karlander. Science 42(11):1651-1652. Nov. 1967.

A1365 Chemical Control of Fusarium Blight of Turfgrass. George A. Bean, R. N. Cook, and A. E. Rabbitt. Plant Disease Reporter 51(10):839-841. Oct. 1967.

A1367 Relative Activity of Germination Inhibitors from Spores of Rust and Smut Fungi. Nancy J. Pritchard and Alois A. Bell. Phytopathology 57(9):932-934. Sept. 1967.

A1368 Relative Quantities of Antifungal Metabolites Produced in Resistant and Susceptible Soybean Plants Inoculated with *Phytophthora megasperma* var. *sojae* and Closely Related Non-pathogenic Fungi. Griscelda Gary, W. L. Klarman, and Margaret Bridge. Canadian J. of Botany 46:285-288. 1968.

A1370 Sterols of *Laminaria.* Glenn W. Patterson. Comparative Biochem. & Physiology 24:501-505. 1968.

A1373 Growth of the Hyperparasite *Darluca filum* on a Chemically Defined Medium. George A. Bean. Phytopathology 58(2):252-253. Feb. 1968.

A1376 Sterol Composition of the Nematodes *Ditylenchus triformis* and *Ditylenchus dipsaci,* and Host Tissues. R. J. Cole and L. R. Krusberg. Experimental Parasitology 21(2):232-239. Oct. 1967.

A1400 Template Requirement of Maize RNA Polymerase. E. R. Stout and R. J. Mans. Plant Physiology 43(3):405-410. March 1968.

A1411 Mineral Nutrition Research with Soybeans in Maryland. Hugh G. Gauch and Russell G. Weigel. The Soybean Digest 28(5):14-16. March 1968.

DEPARTMENT OF DAIRY SCIENCE

Miscellaneous Publications

612 Using Heat-Treated Milk Fat in Frozen Dairy Foods. W. S. Arbuckle, L. F. Blanton, Homer E. Walter, and A. M. Sadler. Ice Cream Field & Ice Cream Trade J. 149(10):38, 40, 46. July, 1967.

Scientific Articles

A1318 The Lipids of Some Rumen Holotrich Protozoa. Ira Katz and M. Keeney. Biochimica et Biophysica Acta 144:102-112. August 1967.

A1350 Uterine Luteolytic Hormone Effect on Ovarian Progesterone Content. W. F. Williams, J. O. Johnston, and M. Lauterbach. J. Dairy Science 50(9):1515-1516. Sept. 1967.

A1353 Effect of Adult Donor Bovine Erythrocytes on Erythrocyte Glucose Content of Recipient Calves. R. B. Johnson and W. E. Stewart. J. Dairy Science '0(11): 1828-1830. Nov. 1967.

A1361 Rapid Method for Isolation of Unesterified Sterols and Its Application to Detection of Milk Fat Adulteration with Vegetable Oils. Ira Katz and Mark Keeney. J. Dairy Science 50(11):1764-1768. Nov. 1967.

DEPARTMENT OF ENTOMOLOGY

Technical Bulletins

A155 The Taxonomic Status of Dipterous Holly Leaf Miners. Leslie A. Kulp. 42 pp. May 1968.

Miscellaneous Publications

605 Field Evaluation of Insecticides for Control of the Alfalfa Weevil in Maryland, 1962-1966. R. M. Coan, V. E. Adler, C. C. Blickenstaff, and A. L. Steinhauer. ARS 33-127:20. March 1968.

660 The Effects of Temperature and Humidity on Egg Hatch of the Lesser Mealworm. Frederick J. Preiss and John A. Davidson. 7 pp. Jan. 1968.

Scientific Articles

A1341 The Taxonomic Status of *Dineutus serrulatus* and *Dineutus analis* in North America (Gyrinidae: Coleoptera). F. E. Wood. Proc. U. S. National Museum 124(3646):1-9. 1968.

A1349 Effects of Soil Fertility on Abundance of Green Peach Aphids on Maryland Tobacco. Allen W. Wooldridge and Floyd P. Harrison. J. Economic Entomology 61(2):387-391. April 1968.

A1351 Control of the Cabbage Looper and Corn Earworm with Polyhedrosis Viruses. Kenneth L. Woodall and L. P. Ditman. J. Economic Entomology 60(6):1558-1561. Dec. 1967.

A1375 Residues in Spinach Grown in Disulfoton-and Phorate-Treated Soil. R. E. Menzer and L. P. Ditman. J. Economic Entomology 61(1):225-229. Feb. 1968.

A1379 Host Plant Preference of Alfalfa Weevil in the Field. H. Desmond Byrne and C. C. Blickenstaff. J. Economic Entomology 61(1):334-335. Feb. 1968.

A1386 Oxidative Metabolism of Phosphamidon in Rats and a Goat. G. P. Clemons and R. E. Menzer. Agr. and Food Chemistry 16(2):312-318. Mar./Apr. 1968.

A1431 A Quantitative Study of Mitotic Divisions of Haemocytes of *Galleria mellonella* Larvae. Jack Colvard Jones and Daisy P. Liu. J. Insect Physiology 14:1055-1061. 1968.

DEPARTMENT OF HORTICULTURE

Scientific Articles

A1290 Preservation of Fresh Food Quality by Gas Exchange: A New Approach to Food Preservation. Amihud Kramer, S. J. Palmer, and J. G. Kaffezkis. HortScience, Amer. Soc. Hort. Sci. 3(2):64-66. Summer 1968.

A1372 Some Factors Affecting Growth and Flower Initiation of Greenhouse Azaleas. James B. Shanks and Conrad B. Link. Proc. Amer. Soc. for Hort. Sci. 92:603-614. June 1968.

A1384 Gas Chromatographic Analysis of Fruit Tissue Polysaccharides. Mansur Tavakoli and Robert C. Wiley. Proc. Amer. Soc. Hort. Sci. 92:772-779. June 1968.

A1395 Relation of Trimethylsilyl Derivatives of Fruit Tissue Polysaccharides to Apple Texture. Mansur Tavakoli and Robert C. Wiley. Proc. Amer. Soc. Hort. Sci. 92:780-787. June 1968.

Miscellaneous Publications

663 Chemical Thinning—Today and Tomorrow. Arthur H. Thompson. Proc. Md. State Hort. Soc. Mountaineer Grower 275:8-12. 1968.

664 Processing Tomato Variety Trials—1967. F. F. Angell, B. A. Twigg, and Dorothy Eiker. Hort. Dept. Res. Mimeo Series HR 42-68:1-13. 1968.

DEPARTMENT OF POULTRY SCIENCE

Miscellaneous Publications

637 Improved Nutrient Composition Data of Feed Ingredients; Amino Acid and Other Nutrient Specifications for Linear Programming of Broiler Rations. G. F. Combs and Hugh Nott. Feedstuffs 39(42):36. Oct. 21, 1967.

638 Data Processing of Feed Ingredient Composition Data. Hugh Nott and G. F. Combs. Feedstuffs 39(41):21. Oct. 14, 1967.

650 Consumer Study of Poultry Giblets. M. Hal Taylor and N. V. Helbacka. Multilithed Circular 5 pp. Dec. 1967.

661 Improved Chick Bioassays for Available Lysine and Available Methionine. G. F. Combs, E. H. Bossard, and G. R. Childs. Feedstuffs 40(8):36. Feb. 24, 1968.

Scientific Articles

A1258 Chicken Blood Volume: The Hematocrit and Comparison of I^{131} and Evans Blue Methods. A. W. Kotula and N. V. Helbacka. Poultry Science 47(1):26-31. Jan. 1968.

DEPARTMENT OF VETERINARY SCIENCE

Scientific Articles

A1288 Some Studies on the Infectious Bursal Agent. Carol Snedeker, F. W. Wills, I. M. Moulthrop. Avian Diseases 11(4):519-528. Nov. 1967.

A1332 Effect of 5-Iodo-2′-Deoxyuridine on Multiplication of Infectious Bovine Rhinotracheitis Virus. Mary G. Lillie and S. B. Mohanty. The Cornell Veterinarian LVIII(2):278-288. Apr. 1968.

A1354 Identification of *Haemophilus gallinarum* in Artificially Infected Chickens. R. L. Peters, J. E. Faber, and H. M. DeVolt. Poultry Science 47(1):123-129. Jan. 1968.

A1380 Evaluation of Erythromycin in the Treatment of Infectious Bovine Mastitis. E. J. Schultz. J. Amer. Veterinary Medical Assn. 152:4(376-379). Feb. 15, 1968.

A1487 Apparent Asymptomatic Left Abomasal Displacement in a Cow. Thomas F. Albert and Donald B. Ramey. J. Amer. Veterinary Medical Assoc. 152(8): 1125-1130. Apr. 15, 1968.

CURRENT PROJECTS

(These are projects and not publications available to the public)

DEPARTMENT OF AGRICULTURAL ECONOMICS

Project	
A-18-au	Dairy Adjustment and Supply Response in Maryland and the Northeast. J. W. Wysong and Graduate Assistants.
A-18-ax	Organization of the World's Agricultural Resources. P. W. Foster and Graduate Assistants.
A-18-ba	Optimizing Returns to Resources on the Eastern Shore of Maryland. S. Ishee, B. V. Lessley, and Graduate Assistant.
A-18-bb	Maryland Farm and Open Country Real Estate Transfers. R. A. Murray and Graduate Assistant.
A-18-bc	An Economic Study of Agricultural Labor in Northeast States. J. W. Wysong and Graduate Assistant.
A-19-ac	Comparative Impact of Current and Alternative Systems of Taxation in Maryland on Farmers and Other Economic Groups and Among Counties. W. P. Walker.
A-19-ad	Demand for and Availability of Land and Water Oriented Recreation Facilities in Maryland: Economic Analysis. D. F. Tuthill and Graduate Assistant.
A-19-ae	An Analysis of the Effect of U. S. Agricultural Policies on Maryland's Agriculture. G. M. Beal and Graduate Assistant.
A-26-bm	The Export Market for Maryland Agricultural Products. Implications of the European Common Market for Midwestern Agriculture. J. R. Moore and Graduate Assistant.
A-26-bo	Analysis of Processing Efficiency and Costs in Broiler Processing Plants. F. E. Bender and Graduate Assistants.
A-26-BP	An Optimum Location of Livestock and Meat Marketing Facilities in the South. R. F. McDonald and Graduate Assistant.
A-26-bq	Alternative Marketing Systems for Eggs in the Northeast. F. E. Bender, J. M. Mills, and Graduate Assistant.
A-26-br	Milk Assembly, Processing and Distribution Systems and Practices. G. M. Beal and Graduate Assistant.
A-26-bs	An Economic Analysis of the Role of Farmer Cooperatives as Marketing Organizations. R. J. Beiter.
A-26-bu	Evaluation of Market Structure Performance in Marketing N. E. Fruits and Vegetables. J. L. Cain and Graduate Assistant.
A-26-bv	Economic Analysis of the Market Structure of the Commercial Fishing Industry in the Northeast. R. E. Suttor, Robert H. Wuhrman, and Graduate Assistants.
A-26-bw	An Analysis of the Feasibility of New or Reorganized Agricultural Marketing Facilities in Selected Areas of Maryland: A Model Approach. H. D. Smith and Graduate Assistant.
A-26-bx	Impact of Market Structure on Innovations in the Agricultural Industries. J. R. Moore and Graduate Assistant.
A-26-by	An Economic Analysis of the Forest Marketing Structure in Maryland. H. D. Smith and Graduate Assistant.
A-26-bz	Structure of Maryland Grain Prices. R. F. McDonald and Graduate Assistant.

DEPARTMENT OF AGRICULTURAL AND EXTENSION EDUCATION

T-12	An Analysis of the Factors Affecting the Status of Private Forest Recreation Development in Garrett County, Maryland. V. R. Cardozier and Graduate Assistant.
T-14	A Study of the Process and Product of Evaluation of Secondary School Vocational Agriculture Programs in Maryland. A. H. Krebs and Graduate Assistants.
T-15	Communications and Decision Making Patterns in a Large Organization. J. W. Longest.
T-16	An Analysis of the Factors Affecting the Status of Private Forest Recreation Development in Garrett County, Maryland. F. Howard Forsyth and J. W. Longest.

DEPARTMENT OF AGRICULTURAL ENGINEERING

R-11-h	Production, Harvesting, Curing and Storing Maryland Tobacco: Mechanization of Tobacco Harvest. (Coop. Department of Agronomy) P. N. Winn, E. W. Martin, N. T. Martin, and J. H. Hoyert.
R-18	Development of Equipment and Improved Methods for Harvesting Sweet Potatoes. G. J. Burkhardt, E. W. Martin, and N. T. Martin.
R-21	Development and Construction of Specialized Facilities and Equipment for Use in Agricultural Research. G. J. Burkhardt and E. W. Martin.
R-22	Principles of Mechanical Harvesting of Fruits and Vegetables. (Coop. Department of Horticulture) G. J. Burkhardt, L. E. Scott, and E. W. Martin.
R-24	Stability of Farm Structures Subjected to Lateral Loads. K. E. Felton.
R-25	Performance Characteristics of Screw Feeders and Screw Conveyors. G. J. Burkhardt and Graduate Assistant.
R-26	Effect of Rate of Displacement on Shear Strength of Soil as Measured with a Torsional Shearing Device. W. L. Harris.
R-27	Effects of Fuel Charge Properties on the Performance of LP Gas Engines. W. L. Harris.
RB-11-g	Tobacco Housing. (Coop. Department of Agronomy) P. N. Winn, R. L. Green, E. W. Martin, N. T. Martin, O. E. Street, and J. H. Hoyert.
RHB-23	Application of Energy for Control of Insects. (Coop. Departments of Agronomy and Entomology; ARS, USDA) W. L. Harris, N. A. Clark, J. W. Neal, C. C. Blickenstaff, R. M. Coan, and Graduate Assistant.
RM-1	Environmental Requirements of Poultry. (Coop. Department of Poultry Science) K. E. Felton, N. T. Martin, C. S. Shaffner, and Edmund Hoffman.

DEPARTMENT OF AGRONOMY

B-43	Soybean Varietal Improvement. J. A. Schillinger, Jr. and Graduate Assistant.
B-50	Breeding for Better Dent Corn. R. G. Rothgeb and N. A. Clark.
B-56-i	Breeding of Improved Varieties of Forage Species Adapted to the Northeast. J. A. Schillinger, Jr.
B-56-j	Pasture Evaluation Using Beef Steers. A. M. Decker.
B-66	Wheat Breeding and Evaluation. R. G. Rothgeb and J. L. Newcomer.
B-67	Varietal Improvement in Barley and Oats. R. G. Rothgeb.
B-73	Morphological and Physiological Responses of Perennial Forage Grasses. A. M. Decker, N. A. Clark, and Graduate Assistants.
B-74	Midland Bermudagrass Hay Production, Feeding Value and Stand Persistence as Affected by Nitrogen Fertilization and Harvest Frequency. A. M. Decker, N. A. Clark, and R. W. Hemken.
B-75	Evaluation of Sod-seeded Forage Species to Supplement and Improve Permanent Pastures. A. M. Decker.
B-76	Red Clover Breeding Investigations. J. A. Schillinger, Jr., Omar Morgan, and Graduate Assistant.
B-77	Forage Crop Variety Evaluation in Maryland. J. A. Schillinger, Jr.
B-79	Use of Herbicides to Control Weeds in Forages. J. V. Parochetti and Gary Reedy.
B-85	Late Planting and Winter Survival in Oats. R. G. Rothgeb.
B-87	Factors Contributing to Maximum Production in Maryland Tobacco. O. E. Street and J. H. Hoyert.
B-89	Studies of Some Fundamental Physio-Chemical Relationships of Tobacco with Respect to Cultural, Fertilization, Curing and Fermentation Practices. O. E. Street, J. H. Hoyert, Jr., and C. G. McKee.
B-94	The Effects of Physical Characteristics of Herbicides on Efficiency and Mode of Action when Used on Corn and Soybeans. S. R. Colby, J. V. Parochetti, and Gary Reedy.
B-95	A Study of the Seed Germination, Rhizome Development and Control Methods of Johnson Grass. J. V. Parochetti.
B-96	To Investigate the Agronomic Feasibility of Transplanting Tobacco Seedlings in Pressed Peat-Soil Cubes. J. H. Hoyert.
B-97	Differential Harvesting Management of Red Clover and Red Clover-timothy Stands Under Three Levels of Fertilization. A. M. Decker.
B-98	Physiological and Biochemical Mechanism of Selectivity of Herbicides. S. R. Colby and J. V. Parochetti.
B-99	Factors Related to Irrigation of Tobacco. O. E. Street, C. G. McKee, and J. H. Hoyert, Jr.

B-101	The Effect of Modified Cultural Practices and Environmental Control of Curing Upon the Adaptability to Mechanization and Quality of Maryland Tobacco. (Coop. Department of Agricultural Engineering) J. H. Hoyert and P. N. Winn.
B-103	Tobacco Breeding, Testing and Quality Evaluations of Maryland Tobacco. M. K. Aycock.
B-104	Tufcote Bermudagrass—Adaptations and Management Requirements for Turf. E. E. Deal.
B-105	Management of Kentucky 31 Tall Fescue for Park, Playground and Athletic Field Turf. E. E. Deal.
B-106	Factors Affecting Turf Quality and Rate of Maturity of Bluegrass—Red Fescue Sod. E. E. Deal.
B-107	Effectiveness and Residual Properties of Several Herbicides Used in Turfgrass Areas. E. E. Deal.
B-108	Effect of Fall and Spring Plowing on Soil Moisture, Soil Aggregate Stability and Corn Yield Under Various Cropping Systems. E. Strickling and Graduate Assistant.
B-109	Breeding and Evaluation of Kentucky Bluegrass for Turf. Development of More Precise Evaluation Techniques for Bluegrass Turf Characteristics. E. E. Deal.
B-110	Climate of the Northeast—Analysis and Relationship to Plant Response. H. G. Siegrist.
BG-2	Summer Annual Forages for Lactating Dairy Cows. (Coop. Department of Dairy Science) N. A. Clark, B. A. Schneider, R. W. Hemken, and Graduate Assistant.
BG-3	Growth Responses of Corn and Alfalfa to Soil Fertility and Irrigation. (Coop. Department of Dairy Science) N. A. Clark, J. H. Vandersall, and Graduate Assistant.
J-95	Development of Improved Strains of Maryland Tobacco Resistant to Disease, M. K. Aycock, O. D. Morgan. J. Hoyert, and H. A. Skoog.
O-48	Field and Laboratory Soil Characterization Investigations as Related to Soil Genesis, Classification and Utilization. J. E. Foss.
O-54	Clay Mineralogy of Maryland Soils. D. S. Fanning.
O-55	Soil Test Studies. J. H. Axley and J. R. Miller.
O-57	Behavior of Nitrogen in the Soil. (Coop. ARS, Soil Conservation Service, USDA) J. J. Axley and J. O. Legg.
O-62	Micronutrient Requirements of Corn on Important Maryland Soils. J. H. Axley.
O-64	Effect of Nitrogen, Phosphorus and Potassium on the Growth and Development of Forages. V. A. Bandel.
O-71	Nutrient Balance in Orchardgrass as Related to Differential Fertilization. D. F. Bezdicek.
O-73	Nutrient Requirements of Summer Annuals for Forage. C. B. Kresge.
O-74	Effect of Differential Fertilization on Forage Production and Chemical Composition of Red Clover. C. B. Kresge.
O-75	The Response of Corn to Fall Vs. Spring Plowing, Broadcast Vs. Plow Down Fertilizer and Fall Vs. Spring Fertilization. V. A. Bandel.
O-76	Effect of Fall and Spring Plowing on Soil Moisture, Soil Aggregate Stability and Corn Yield Under Various Cropping Systems. E. Strickling and Graduate Assistant. (Cross ref. with B-108)

DEPARTMENT OF ANIMAL SCIENCE

C-25-a	The Effects of Roughage Preparation. E. C. Leffel and J. E. Foster.
C-33	A Study of the Effect of Menhaden Fish Meal on the Quality of Protein of Swine Diets and on Total Crude Protein Requirements for Growth of Swine. E. P. Young and J. E. Foster (D. G. Snyder and R. R. Kifer, Bureau of Commercial Fisheries, Collaborators).
C-34	A Study of the Nutritional and Physiological Influences on Variability of Ovulation Rate and Embryonic Survival in Swine. E. P. Young (H. J. Brinkley, Dept. of Zoology, Collaborator).
C-35	Studies on the Efficiency and Composition of Growth in Swine as Affected by Protein and Energy Consumption. E. P. Young, W. R. Bounds, and G. S. Stanton, Jr.
C-38	A Study of Factors that Influence Feed Consumption by Suckling Pigs. E. P. Young, J. E. Foster, and W. R. Bounds.
C-39	Analyses of Records of Beef Cattle Herds in Maryland. W. W. Green and W. R. Stevens.

C-40	A Study of the Use of Measurements for the Evaluation of Beef Breeding Cattle. W. W. Green, W. R. Stevens, and M. B. Gauch.
C-41	A Study of Variations in Values of Criteria Used in Selection Indices for Beef Cattle. J. Buric and J. E. Foster.
C-42	A Study of Rates of Ruminal Digestion and Absorption from the Rumen. E. C. Leffel, J. E. Foster, and Graduate Assistant.
C-43	Procurement and Study of the Gnotobiotic Ruminant. E. C. Leffel, J. E. Foster, and Graduate Assistant.
C-44	Equine Serum Transaminases as Related to Muscular Work and Protein Nutrition. E. C. Leffel and G. C. DeOms.

DEPARTMENT OF BOTANY

F-12	The Native Plants of Maryland, Their Occurrence, Distribution and Economic Importance. R. G. Brown, R. D. Rappleye, and Graduate Assistant.
F-18	Genetic Control of the First Division Association of Homologous Chromosomes and Fertility in *Zea mays* and *Capsicum frutescens.* D. T. Morgan, Jr. and R. D. Rappleye.
F-19	Anatomical, Physiological and Ecological Studies on *Myriophyllum spicatum* L. R. G. Brown, R. D. Rappleye, and Graduate Assistant.
F-20	An Ecological Study of the Patuxent Estuary. R. D. Rappleye and Graduate Assistant.
J-91	Fungicidal Materials on Cellular Metabolism and Their Usefulness for the Field Control of Vegetable Diseases. H. D. Sisler, J. G. Kantzes, and Graduate Assistants.
J-93	Treatment of Soil and Underground Parts of Plants for the Control of Plant Diseases. O. D. Morgan, Jr., J. G. Kantzes, L. R. Krusberg, and W. L. Klarman.
J-95	Development of Improved Strains of Maryland Tobacco Resistant to Diseases. O. D. Morgan, M. K. Aycock, J. Hoyert, and H. A. Skoog.
J-97	Physiology and Biochemistry of Nematode and Nematode-Host Relationships. L. R. Krusberg, Margaret Madison, and Graduate Assistants.
J-98	Identification, Characterization and Control of Certain Viruses Affecting Economic Plants in Maryland. M. K. Corbett, R. W. Vickery, and Graduate Assistants.
J-99	The Nature and Control of Diseases of Ornamentals and Turf Grasses in Maryland. G. A. Bean and W. L. Klarman.
J-101	Forest Tree Seedlings and Soil Fungi Relationships. W. L. Klarman and Graduate Assistant.
K-8-c	Biophysical and Biochemical Factors in Plant Nutrition. H. G. Gauch, R. W. Krauss, R. A. Galloway, J. D. Lockard, and Russell Weigel.
K-9	Regulations of Protein and Nucleic Acid Biosynthesis Processes in Plant Tissues. R. J. Mans.
K-10	Nutrient and Environmental Factors Which Affect the Formation of Lipids in Plants. G. W. Patterson.
K-11	Environmental Effects on Growth and Photosynthesis. E. P. Karlander and Graduate Assistants.

DEPARTMENT OF DAIRY SCIENCE

G-34	Chemical Changes in Milk Fat as Related to the Flavor of the Milk. R. L. King, Marianne Oskarsson, and Graduate Assistant.
G-35	The Analysis of Dairy Products. Mark Keeney and J. F. Mattick.
G-37	Physiology of Metabolic Diseases of Cattle. J. L. Cason and W. F. Williams.
G-39	Studies on the Mode of Digestion, Absorption and Utilization of Feeds by Ruminants and Their Associated Bacteria. J. L. Cason, R. W. Hemken, D. M. McKinstry, and Graduate Assistant.
G-42	Methods of Processing and Other Factors Affecting the Quality of Ice Cream. W. S. Arbuckle and Graduate Assistant.
G-46	The Relationship of the Hypophysical Growth Hormone and of the Pituitary-Adrenal System to the Productive Capacity of Dairy Cattle for Reproduction and Milk Production. W. F. Williams and Graduate Assistant.
G-47	The Nutritive Evaluation of Forages. R. W. Hemken, Khageswar Pradhan, and Graduate Assistant.
G-48	Flavor Quality of Concentrated Milk Products as a Factor in Milk Utilization and Marketing. Mark Keeney, Dorothy Carpenter, and Graduate Assistant.

G-50	The Physiology of Progesterone Metabolism. W. F. Williams and Graduate Assistant.
G-52	A Study of Factors Affecting the Voluntary Intake, Availability and Utilization of Nutrients in Forages for Growth and Milk Production. R. W. Hemken, J. H. Vandersall, and Graduate Assistant.
G-53	A Study of the Development, Improvement or Standardization of Manufacturing Processes for the Production of Various Cheeses and the Effect of Specific Factors on the Flavor, Body and Texture of These Cheeses. J. F. Mattick and Graduate Assistant.
G-54	Analyses of Production and Feed Data from Dairy Records. T. P. Fairchild, J. L. Cason, and Graduate Assistant.
G-55	Factors Influencing the Absorption, Transport, Retention and Excretion of Pesticide Chemicals in Dairy Animals. R. L. King and Graduate Assistant.

DEPARTMENT OF ENTOMOLOGY

H-29-n	Chemical Control of Insect Pests of Sweet Corn. F. P. Harrison.
H-46-e	Concentrated Pesticide Sprays. Evaluation of New Insecticides on Vegetable Crops. M. Tysowsky.
H-48	Chemical Control of Orchard Inescts. W. E. Bickley, Castillo Graham, E. R. Krestensen, and J. A. Davidson.
H-64	An Evaluation of the Effectiveness of Commercial Insect Control Practices on Canning Crops. M. Tysowsky and W. E. Bickely.
H-67	Pesticide Residues in or on Raw Agricultural Commodities. R. E. Menzer, M. Tysowsky, F. P. Harrison, and E. L. Fontanilla.
H-71-d	Alfalfa Insects, Their Biology and Control. J. W. Neal, Jr. and W. E. Bickley.
H-72	Physiology of Insect Reproduction. J. C. Jones and Graduate Assistant.
H-73-a	The Mosquito Fauna in Selected Swamps, Marshes and Impoundments. W. E. Bickley and S. R. Joseph.
H-74	Biology and Control of Tobacco Insects. F. P. Harrison.
H-76	Comparative Morphology and Physiology of Insect Blood Cells. J. C. Jones and Daisy P. Liu.
H-81	Utilization of the Polyhedrosis Virus for Commercial Control of the Cabbage Looper. E. D. Thomas.
H-83	Biology and Control of Loblolly Pine Cone Insects in Maryland. W. E. Bickley, F. E. Wood, and B. D. Schaber.
H-84	Host Preference of Alfalfa Weevil, *Hypera postica* (Gyll.) in Relation to Plant Produced Attractants and Repellents. R. E. Menzer.
H-85	Transformation of Insecticides by Plants. Metabolic Transformations of Dimethoate by Plants. R. E. Menzer and Graduate Assistants.
H-86	The Biology of Biting Midges of the genus *Culicoides* in Maryland. D. H. Messersmith and Graduate Assistant.
H-87	Control of Bird Depredation. D. H. Messersmith.
H-89	Development of Controls for Underground Insect Injury to Sweet Potatoes. M. Tysowsky and F. P. Harrison.
H-90	Oxidative Dealkylation of Pesticides. R. E. Menzer and Graduate Assistant.
H-91	The Production and Effectiveness of the Nuclear Polyhedrosis of the Fall Armyworm (*Spodoptera frugiperda*). E. D. Thomas and C. F. Reichelderfer.
H-92	The Biology and Control of the Lesser Mealworm, *Alphitobius diaperinus* Panzer in Maryland Broiler Houses (Coleoptera: Tenebrionidae). J. A. Davidson and Graduate Assistant.
H-93	The Influence of Nutritional Variation in the Development of Larvae and Adult Honey Bees. W. E. Bickley and Elton Herbert.

COLLEGE OF HOME ECONOMICS

Y-2	Properties of Textile-Furnishing Fabrics and Their Importance to Consumer Satisfaction. T. F. Mitchell.
Y-4	Utilization of Amino Acids from Proteins. Lillian C. Butler, Virginia T. Dawson, Ann Thomas, and Graduate Assistant.
Y-5	Effects of Refrigerator Storage of Fresh Broccoli, Blanching Solution and Packaging on pH, Acids, Chlorophylls, Dehydor and Reduced Ascorbic Acid in Frozen Broccoli. Mary S. Eheart and Dale Queen.

DEPARTMENT OF HORTICULTURE

I-74-a	Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Potted Plants. J. B. Shanks, C. B. Link, and Graduate Assistants.

I-74-b	Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Cut Flower Crops. C. B. Link, J. B. Shanks, and Graduate Assistants.
I-74-c	Cultural and Management Studies for the Production and Maintenance of Woody Plants. C. B. Link, F. R. Gouin, and Thomas MacCubbin.
I-79-m	Relationship of the Mineral Nutrients and of Nutrient Levels to the Growth and Development of Certain Woody Ornamental Plants Growing in Containers. C. B. Link and F. R. Gouin.
I-79-n	The Influence of Temperature and Photoperiod on the Growth and Flowering of the Greenhouse Carnation, *Dianthus caryophyllus* L. C. B. Link, J. B. Shanks, Dan Eltzroth, and Graduate Assistants.
L-73	Adaptation of Fruit Varieties and New Seedlings to Maryland. I. C. Haut, Wm. Morris, and W. A. Matthews.
L-74	Environmental Factors and Cultural Practices in Relation to the Growth and Fruiting Responses of Fruits. A. H. Thompson, B. L. Rogers, and Graduate Assistants.
L-74-b	Chemical Thinning of Peaches. A. H. Thompson, B. L. Rogers, and Graduate Assistants.
L-74-c	Size Control of Fruit Trees with Chemicals. A. H. Thompson, B. L. Rogers, and Graduate Assistants.
L-79-g	Chemical and Non-Chemical Measures for Protection of Perishable Food Commodities in Marketing Channels. G. J. Stadelbacher, L. E. Scott, and Graduate Assistants.
L-79-h	Mineral Nutrition of the Apple with Special Reference to Ca, Mn and Fe. A. H. Thompson, B. L. Rogers, H. G. Gauch (Botany), and Graduate Assistants.
L-79-i	Post-Harvest Physiology of Pomological Fruits. L. E. Scott and Graduate Assistants.
L-100	Vegetative Propagation of Pine by Needle Fascicles. J. B. Shanks and Graduate Assistants.
Q-58-a	Rapid Nutritive Evaluation of Processed Vegetable. A. Kramer, B. A. Twigg, and Graduate Assistants.
Q-58-k	Development of Specifications for Canned Food Quality. A. Kramer, L. E. Scott, and B. A. Twigg.
Q-58-m	Development of New Products and Improved Processing Methods. A. Kramer, R. C. Wiley, B. A. Twigg, and Thelma Chase.
Q-58-n	Suitability of New Varieties of Horticultural Crops for Canning and Freezing. J. D. Long, F. F. Angell, and L. E. Scott.
Q-58-p	Quality Improvement of Canned Apple Slices and Sauce Through Studies of the Relation of Water Insoluble Constituents of the Fresh Fruit to the Textural Quality of the Processed Product. R. C. Wiley, A. H. Thompson, and Graduate Assistants.
Q-58-t	Relationship of Pectinesterase Systems to Fruit and Vegetable Texture. R. C. Wiley and Graduate Assistants.
Q-74	A Study of Regional Adaptation of Certain Vegetable Crops and Varieties in Maryland. J. D. Long, L. E. Scott, and F. F. Angell.
Q-77	Crop Management Studies with Vegetable Crops. C. W. Reynolds, J. D. Long, W. A. Matthews, F. C. Stark, and Graduate Assistants.
Q-77-b	Efficacy and Selectivity of Chemical Herbicides for Controlling Major Weed Species in Truck Crop Production. C. D. Altman, W. A. Matthews, G. J. Stadelbacher, D. A. Eiker, and F. C. Stark.
Q-77-c	The Interrelations of Various Cultural Procedures to the Mechanical Harvesting of Tomatoes. F. F. Angell, J. D. Long, F. C. Stark, and Graduate Assistants.
Q-77-d	Automation of Transportation and Processing of Tomatoes and Tomato Products. A. Kramer, F. F. Angell, B. A. Twigg, and Graduate Assistants.
Q-81	Cantaloupe Breeding and Selection with Particular Reference to Quality and Resistance to Defoliation. F. F. Angell.
Q-81-c	Genetics and Breeding of Sweet Corn. R. J. Snyder, F. F. Angell, and Graduate Assistants.
Q-81-d	Tomato Breeding and Selection with Particular Reference to Adaptation to Mechanical Harvest and to Processing. F. F. Angell, F. C. Stark, Dorothy A. Eiker, and Graduate Assistants.
Q-81-e	*Asparagus officinalis* Breeding and Genetic Studies. R. J. Snyder and Graduate Assistants.
Q-81-f	Breeding of Horticultural Crop Plants. R. J. Snyder, C. B. Link, F. F. Angell, I. C. Haut, F. C. Stark, and Graduate Assistants.

Q-83	Soil - Plant - Water Relationships. C. W. Reynolds, F. C. Stark, and Graduate Assistants.
Q-83-b	Root Distribution and Root Density of Selected Vegetable Crops as Related to the Absorption of Soil Water and the Uptake of P^{32}. C. W. Reynolds, W. A. Matthews, and Graduate Assistant.
Q-84-a	Effect of Traces of Oxygen and Other Gases on the Preservation and Flavor Development of Plant Materials. A. Kramer and Graduate Assistants.
Q-84-b	The Polyphenolase System in Relation to the Corrosion of Tin-lined Containers. L. E. Scott and Graduate Assistants.
Q-85-a	Utilization of Solid and Liquid Wastes Formed in the Manufacture of Vegetable and Cheese Products. A. Kramer, J. F. Mattick, E. C. Leffel, J. Axley, and Graduate Assistants.

MARYLAND STATE COLLEGE

MSC-1	Socio-economic Potential of Rural Families. W. A. Lynk and F. H. Forsyth.

DEPARTMENT OF POULTRY SCIENCE

M-58	Metabolic and Nutritional Studies on Microorganisms Important to the Poultry Industry. Mary S. Shorb, Pauline G. Lund, Winifred R. Knuese, and W. O. Pollard.
M-61	A Study of Causes of Bruising in Transportation of Live Broilers from Farm to Processing Plant and Possible Methods for Their Reduction. (Coop. Department of Agricultural Engineering) N. V. Helbacka, James Nicholson, and P. N. Winn.
M-64	Effects of Gonadal Hormones on Embryonic and Postnatal Bone Growth in Chickens. E. F. Godfrey and C. S. Shaffner.
M-66	Applied Broiler Nutrition Studies. G. F. Combs, E. H. Bossard and J. L. Nicholson.
M-68	Genetic Adaptation for Broiler Breeder Stock. C. S. Shaffner, E. F. Godfrey, and E. Hoffmann.
M-69	The Relationship Between the Activity of the Kreb's Cycle Enzymes and Fertilizing Ability of Fowl Spermatozoa. F. H. Wilcox and R. B. Buckland.
M-70	Inheritance of Lysine Utilization. E. F. Godfrey, C. S. Shaffner, and W. O. Pollard.
M-100	Quality Retention in Poultry Meats as Influenced by Methods of Processing. N. V. Helbacka, C. S. Shaffner, David Wakefield (Computer Science Center), and R. C. Wiley (Horticulture).
M-101	Studies of the Influence of Slush-ice Chilling and Carcass Water Content on the Quality of Processed Poultry. D. E. Bigbee and N. V. Helbacka.
M-102	Studies of Factors Influencing Broiler Carcass Yields, and Microflora of Processed Broilers. D. E. Bigbee, C. S. Shaffner, and P. A. Hanson.
M-207	Study of Chick Red Blood Cell Transketolase as an Index of Thiamine Nutriture. G. F. Combs.
M-208	Use of Chick Bio-Assay in Measuring Specifi Amino Acid Availability. G. F. Combs, E. Bossard, and R. D. Creek.
M-209	Effect of Protein Level and Amino Acid Balance on Voluntary Food Consumption. C. S. Shaffner, G. F. Combs, and R. Peacock.
M-210	Determination of Amino Acid Requirements of Growing Broiler Chicks and Laying Hens. G. F. Combs, E. Bossard, and N. A. Mills, Jr.
M-303	The Performance of Populations of the Domestic Fowl as Influenced by Heritable Physiological Traits and by Genes with Pleiotropic Effects. C. S. Shaffner, W. O. Pollard, and F. K. Wills (Veterinary Science).
M-304	Selection for Viability of Broiler Breeding Stock. C. S. Shaffner, E. F. Godfrey, and E. Hoffmann.
M-305	Genetic Basis for Resistance to Leukosis in the Fowl. C. S. Shaffner and F. K. Wills (Veterinary Science).

DEPARTMENT OF VETERINARY SCIENCE

D-52	Respiratory Disease of Poultry. F. K. Wills, J. A. Newman, I. M. Moulthrop, Carol Snedeker, and G. J. Mizejewski.
D-58	A Study of the Epidemiology of Staphlococcal Mastitis (Bovines) Utilizing Phage Typing. E. J. Schultz and E. Farinas.

D-59 The Investigation of Fluorescent Antibody Technique with Respiratory and Other Diseases of Poultry. J. A. Newman and G. J. Mizejewski.

D-63 A Study of Bovine Respiratory Diseases. S. B. Mohanty, M. G. Lillie, and Graduate Assistant.

D-64 An Investigation to Study the Propagation of Avian Viruses in Tissue Culture. R. B. Johnson, J. A. Newman, and E. Wiseman.

D-65 Studies on Etiology and Pathogenesis, Laboratory Diagnosis and Chemotherapy of Bovine Lymphosarcoma. B. C. Hatziolos and M. Herr.

D-67 Comparative Study of Rabies Virus. K. A. Palmer.

In addition to state and federal funds, the research program of the University of Maryland Agricultural Experiment Station has received support during the year from many public, private and industrial organizations and individuals. It is regretted that space does not permit recognition of all sources of help, but the cooperation of all is herewith gratefully acknowledged.

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